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THE HISTORY OF ANCIENT ASTRONOMY
PROBLEMS AND METHODS

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Ce qui est admirable, ce n'est pas que le champ des étoiles soit si vaste, c'est que l'homme l'ait mesuré.—ANATOLE FRANCE, *Le Jardin d'Épicure.*

I. INTRODUCTION

1. In the following pages an attempt is made to offer a survey of the present state of the history of ancient astronomy by pointing out relationships with various other problems in the history of ancient civilization and particularly by enumerating problems for further research which merit our interest not only because they constitute gaps in our knowledge of ancient astronomy but because they must be clarified in order to lay a solid foundation for the understanding of later periods.

I wish to emphasize from the very beginning that the attitude taken here is of a very personal character. I do not believe that there is any single approach to the history of science which could not be replaced by very different methods of attack; only trivialities permit but one interpretation. I must confess still more: I cannot even pretend to be complete in the selection of topics essential for our understanding of ancient astronomy,[1] nor do I wish to conceal the fact that many of the steps which I myself have taken were dictated by mere accident. To mention only one example: without having been brought into contact with a recently purchased collection of Demotic papyri in Copenhagen, I would never have undertaken the investigation of certain periods of Hellenistic and Egyptian astronomy which now seem to me to constitute a very essential link between ancient and medieval astronomy. In other words, though I have always tried to subordinate any particular research problem to a wider program of systematic analysis, the impossibility of elaborate long-range planning has again and again been impressed upon me. The situation is comparable to entering a vast mountainous region on a single trail; one must simply follow the winding path, trying to give account of its general direction, but one can never predict with certainty what new vistas will be exposed at the next turn.

2. The enormous complexity of the study of ancient astronomy becomes evident if we try to make the first, and apparently simplest, step of classification: to distinguish between, say, Mesopotamian, Egyptian, and Greek astronomy, not to mention their direct successors, such as Hindu, Arabic, and medieval astronomy. Neither geographically nor chronologically nor according to language can clear distinctions be made. Entirely different conditions underlie the astronomy in Egypt of the Middle and New kingdoms than in the periods after the Persian conquest. Greek astronomy of Euclid's time has very little in common with Hipparchus' astronomy only a hundred and fifty years later. It is evident that it is of very little value to speak about a "Babylonian" astronomy regardless of period, origin, and scope. And, worst of all, the concept "astronomy" itself undergoes changes in meaning when we speak about different periods. The fanciful combination of a group of brilliant stars to form the picture of a "bull's leg" and the computation of the irregularities in the moon's movement in order to predict accurately the magnitude of an eclipse are usually covered by the same name! For methodological reasons it is obvious that a drastic restriction in terminology must be made. We shall here call "astronomy" only those parts of human interest in celestial phenomena which are amenable to mathematical

[1] Also the bibliography, given at the end, is very incomplete and is only intended to inform the reader where he can find further details of the specific viewpoint discussed here and to list the original sources.

treatment. Cosmogony, mythology, and applications to astrology must be distinguished as clearly separated problems —not in order to be disregarded but to make possible the study of the mutual influence of essentially different streams of development. On the other hand, it is necessary to co-ordinate intimately the study of ancient mathematics and astronomy because the progress of astronomy depends entirely on the mathematical tools available. This is in conformity with the concept of the ancients themselves: one need only refer to the original title of Ptolemy's "*Almagest*," namely, "Mathematical Composition."

3. The study of ancient astronomy will always have its center of gravity in the investigation of the Hellenistic-Roman period, represented by the names of Hipparchus and Ptolemy. From this center three main lines of research naturally emerge: the investigation of the previous achievements of the Near East; the investigation of pre-Arabic Hindu astronomy; and the study of the astronomy of late antiquity in its relation to Arabic and medieval astronomy. This last-mentioned extension of our program beyond antiquity proper is not only the natural continuation of the original problem but constitutes an integral part of the general approach outlined here. Astronomy is the only branch of the ancient sciences which survived almost intact after the collapse of the Roman Empire. Of course, the level of astronomical studies dropped within the boundaries of the remnants of the Roman Empire, but the tradition of astronomical theory and practice was never completely lost. On the contrary, the rather clumsy methods of Greek trigonometry were improved by Hindu and Arabic astronomers, new observations were constantly compared with Ptolemy's results, etc. This must be paralleled with the total loss of understanding of the higher branches of Greek mathematics before one realizes that astronomy is the most direct link connecting the modern sciences with the ancient. In fact, the work of Copernicus, Brahe, and Kepler can be understood only by constant reference to ancient methods and concepts, whereas, for example, the meaning of the Greek theory of irrational magnitudes or Archimedes' integrations were understood only after being independently rediscovered in modern times.

There are, of course, very good reasons for the fact that ancient astronomy extended with an unbroken tradition deep into modern times. The structure of our planetary system is such that it is simple enough to permit the achievement of relatively far-reaching results with relatively simple mathematical methods, but complicated enough to invite constant improvement of the theory. It was thus possible to continue successfully the "ancient" methods in astronomy at a time when Greek mathematics had long reached a dead end in the enormous complication of geometric representation of essentially algebraic problems. The creation of the modern methods of mathematics, on the other hand, is again most closely related to astronomy, which urgently required the development of more powerful new tools in order to exploit the vast possibilities which were opened by Newton's explanation of the movement of the celestial bodies by means of general principles of physics. The confidence of the great scientists of the modern era in the sufficiency of mathematics for the explanation of nature was largely based on the overwhelming successes of celestial mechanics. Essentially the same held for scholars in classical times. In antiquity, mathematical tools were not available to explain any

physical phenomena of higher complexity than the planetary movement. Astronomy thus became the only field of ancient science where indisputable certainty could be reached. This feeling of the superiority of mathematical astronomy is best expressed in the following sentences from the introduction to the *Almagest:* "While the two types of theory could better be called conjecture than certain knowledge —theology because of the total invisibility and remoteness of its object, physics because of the instability and uncertainty of matter— . . . . mathematics alone . . . . will offer reliable and certain knowledge because the proof follows the indisputable ways of arithmetic and geometry."[2]

II. EGYPT

4. A few words must be said about Egyptian mathematics before discussing the astronomical material. Our main source for Egyptian mathematics consists of two papyri[3]—certainly not too great an amount in view of the length of the period in question! Still, it seems to be a fair assumption that we are well enough informed about Egyptian mathematics. Not only are both papyri of very much the same type but all additional fragments which we possess match the same picture—a picture which is paralleled by economic documents in which occur precisely those problems and methods which we find in the mathematical papyri. The Egyptian mathematical texts, furthermore, find their direct continuation in Greek papyri,[4] which again show the same pattern. It is therefore safe to say that Egyptian mathematics never rose above a very primitive level. So far as astronomy is concerned, numerical methods are of primary importance, and, fortunately enough, this is the very part of Egyptian mathematics about which we are best informed. Egyptian arithmetic can be characterized as being predominantly of an "additive" character, that is, its main tendency is to reduce all operations to repeated additions. And, because the process of division is very poorly adaptable to such procedures, we can say that Egyptian mathematics does not provide the most essential tools for astronomical computation. It is therefore not surprising that none of our Egyptian astronomical documents requires anything more than simple operations with integers. Where the complexity of the phenomena exceeded the capacity of Egyptian mathematics, the strongest simplifications were adopted, consequently leading to little more than qualitative results.

5. The astronomical documents of purely Egyptian origin are the following: Astronomical representations and inscriptions on ceilings of the New Kingdom,[5] supplemented by the so-called "diagonal calendars" on coffin lids of the Middle Kingdom[6] and by the Demotic-Hieratic papyrus "Carlsberg 1."[7] Secondly, the Demotic papyrus "Carlsberg 9," which shows the method of determining new moons.[8] Though written in Roman

[2] *Almagest* I, 1 (ed. Heiberg I, 6, 11 ff.).

[3] Math. Pap. Rhind [Peet *RMP;* Chace *RMP*] and Moscow mathematical papyrus [Struve *MPM*]. For a discussion of Egyptian arithmetic see Neugebauer [1], for Egyptian geometry Neugebauer [2], and, in general, Neugebauer *Vorl.* The most recent attempt at a synthesis of Egyptian science, by Flinders Petrie (*Wisdom of the Egyptians* [London, 1940]), must unfortunately be considered as dilettantish not only because of its disregard of essential source material but also because of its lack of understanding for the mathematical and astronomical problems as such.

[4] The continuation of this tradition is illustrated by the following texts: Demotic: Revillout [1]; Coptic: Crum *CO*, No. 480, and Sethe *ZZ*, p. 71; Greek: Robbins [1] or Baillet [1]. For Greek computational methods in general, see Vogel [1].

[5] Examples: The Nut-pictures in the cenotaph of Seti I (Frankfort *CSA*) and Ramses IV (Brugsch *Thes.* 1) and analogous representations in the tombs of Ramses VI, VII, and IX.

[6] Cf. Pogo [1] to [4].

[7] Lange-Neugebauer [1].

[8] Neugebauer-Volten [1].

times (after A.D. 144), this text undoubtedly refers to much older periods and is uninfluenced by Hellenistic methods. A third group of documents, again written in Demotic, concerns the positions of the planets.[9] In this case, however, it seems to be very doubtful whether these tables are of Egyptian origin rather than products of the Hellenistic culture; we therefore postpone a discussion to the section on Hellenistic astronomy.[10] The last group of texts is again inscribed on ceilings and has been frequently discussed because of their representation of the zodiac.[11] There can be no doubt that these latter texts were deeply influenced by non-Egyptian concepts characteristic for the Hellenistic period. The same holds, of course, for the few Coptic astronomical documents we possess.[12] It is, finally, worth mentioning that not a single report of observations is preserved, in strong contrast to the abundance of observational records from Mesopotamia. It is hard to say whether this reflects a significant historical fact or merely that we are at the mercy of the accidents of excavation.

Speaking of negative evidence, three instances must be mentioned which play a more or less prominent role in literature on the subject and have contributed much to a rather distorted picture of Egyptian astronomy. The first point consists in the idea that the earliest Egyptian calendar, based on the heliacal rising of Sothis, reveals the existence of astronomical activity in the fourth millennium B.C. It can be shown, however, that this theory is based on tacit assumptions which are very implausible in themselves and that the whole Egyptian calendar does not presuppose any systematic astronomy whatsoever.[13] The second remark concerns the hypothesis of early Babylonian influence on Egyptian astronomical concepts.[14] This theory is based on a comparative method which assumes direct influence behind every parallelism or vague mythological analogy. Every concrete detail of Babylonian and Egyptian astronomy which I know contradicts this hypothesis. Nothing in the texts of the Middle and New Kingdom equals in level, general type, or detail the contemporaneous Mesopotamian texts. The main source of trouble is, as usual, the retrojection into earlier periods of a situation which undoubtedly prevailed during the latest phase of Egyptian history. This brings us to the third point to be mentioned here: the assumption of an original Egyptian astrology. First of all, there is no proof in general for the widely accepted assertion that astrology preceded astronomy. But especially in Egypt is there no trace of astrological ideas in the enormous mythological literature which we possess for all periods.[15]

[9] Neugebauer [3]. [10] Cf. below, p. 24.

[11] I know of the following representations of zodiacs: *No. 1* (Ptolemy III and V, i.e., 247/181 B.C.): northwest of Esna, North temple of Khnum (Porter-Moss *TB* VI, p. 118); *Nos. 2 and 3* (Ptolemaic or Roman): El-Salâmûni, Rock tombs (Porter-Moss *TB* V, p. 18); mentioned by L'Hôte, *LE*, pp. 86–87. *No. 4* (Ptolemaic-Roman; Tiberius): Akhmim, Two destroyed temples (Porter-Moss *TB* V, p. 20); mentioned by Pococke *DE*, I, pp. 77–78. *No. 5* (Tiberius): Dendera, Temple of Ḥathor, Outer hypostyle (Porter-Moss *TB* VI, p. 49). *No. 6* (Augustus-Trajan): Dendera, Temple of Ḥathor, East Osiris-chapel central room, ceiling, west half (Porter-Moss *TB* VI, p. 99). *Nos. 7 and 8* (1st cent. A.D.): Athribis, Tomb (Porter-Moss *TB* V, p. 32). *No. 9* (Titus and Commodus): Esna, Temple of Khnum (Porter-Moss *TB* VI, p. 116). *No. 10* (Roman): Dealer in Cairo, publ. Daressy [1], pp. 126–27, and Boll, *Sphaera*, Pl. VI. Five other representations of the zodiacal signs are known from coffins, all from Ptolemaic or Roman times. On the other hand, the original Egyptian constellations are still found on coffins of the Saitic or early Ptolemaic periods.

[12] The only nonastrological Coptic documents known to me are the tables of shadow lengths published by U. Bouriant and Ventre-Bey [1].—P. Bouriant [1] did not recognize that the text published by him was a standard list of the planetary "houses" with no specific reference to Arabic astronomy.

[13] Neugebauer [4], Winlock [1], Neugebauer [5].

[14] Sponsored especially by the "Pan-Babylonian" school.

[15] It is interesting to observe how deeply imbedded is the assumption that astrology must precede as-

The earliest horoscope from Egyptian soil, written in Demotic, refers to A.D. 13;[16] the earliest Greek horoscope from Egypt concerns the year 4 B.C.[17] We shall presently see that the assumption of a very late introduction of astrological ideas into Egypt corresponds to various other facts.

6. It is much easier to show that certain familiar ideas about the origin of astronomy are historically untenable than to give an adequate survey of our real knowledge of Egyptian astronomy. A. Pogo is to be credited with the recognition of the astronomical importance of inscriptions on the lids of a group of coffins from the end of the Middle Kingdom,[18] apparently representing the setting and rising of constellations, though in an extremely schematic fashion. The constellations are known as the "decans" because of their correspondence to intervals of ten days. He furthermore saw the relationship between these simple pictures and the elaborate representations on the ceilings of the tombs belonging to kings of the New Kingdom.[19]

It can be safely assumed that the coffin lids are very abbreviated forms of contemporaneous representations on the ceilings of tombs and mortuary temples of the rulers of the Middle Kingdom. The logical place for these representations of the sky on ceilings explains their destruction easily enough. The earliest preserved ceiling, discovered in the unfinished tomb of Senmut, the vezir of Queen Hatshepsut,[20] is about three centuries later than the coffin lids. Then come the well-preserved ceiling in the subterranean cenotaph of Seti I[21] and its close parallels in the tomb of Ramses IV[22] and later rulers.[23] The difficulties we have to face in an attempt to explain these texts can best be illustrated by a brief discussion of the abovementioned papyrus "Carlsberg 1." This papyrus was written more than a thousand years after the Seti text but was clearly intended to be a commentary to these inscriptions. In the papyrus we find the text from the cenotaph split into short sections, written in Hieratic, which are followed by a word-for-word translation into Demotic supplemented by comments in Demotic. The original text is frequently written in a cryptic form, to which the Demotic version gives the key. We now know, for instance, that various hieroglyphs were replaced by related forms in order to conceal the real contents from the uninitiated reader. How successfully this method worked is shown by the fact that one such sign, which is essential for the understanding of a long list of dates of risings and settings of the decans, was used at its face value for midnight instead of evening.[24] It is needless to emphasize what the recognition of such substitutions means for the correct understanding of astronomical texts. A complete revision of all previously published material is needed in the light of this new

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tronomy. Brugsch called his edition of cosmogonic and mythological texts "astronomische und astrologische Inschriften" in spite of the fact that these texts do not betray the slightest hint of astrology.

[16] Neugebauer [6].

[17] *Pap. Oxyrh.* 804. From this time until A.D. 500 more than sixty individual horoscopes, fairly equally distributed in time, are known to me.

[18] Cf. n. 6.

[19] Some of Pogo's assumptions must, however, be abandoned, because they are based on the distinction of different types of such coffin inscriptions. A close examination of these texts (and also unpublished material) shows that all preserved samples belong to the same type. A systematic edition of all these texts is urgently needed if we are to obtain a solid basis for the study of Egyptian constellations.

[20] Winlock [2], pp. 34 ff., reprinted in Winlock *EDEB*, pp. 138 ff., and Pogo [5]. The final publication has not yet appeared.

[21] Frankfort *CSA*.

[22] Brugsch *Thes.* I opposite pp. 174–75, but incomplete (cf. Lange-Neugebauer [1], p. 90).

[23] Cf. n. 5.

[24] Sethe, *ZAA*, p. 293, n. 1, and Lange-Neugebauer [1], p. 63.

insight into the Egyptian scheme of describing the rising and setting of stars the year round. One point, however, must be kept in mind in every investigation of Egyptian constellations. One must not ascribe to these documents a degree of precision which they were never intended to possess. I doubt, for example, very much whether one has a right to assume that the decans are constellations covering exactly ten degrees of a great circle on the celestial sphere. I think it is much more plausible that they are constellations spread over a more or less vaguely determined belt around the sky, just as we speak about the Milky Way. It is therefore methodically wrong to use these star lists and the accompanying schematic date lists for accurate computations, as has frequently been attempted.

The second Demotic astronomical document, papyrus Carlsberg 9, is much easier to understand and gives us full access to the Egyptian method of predicting the lunar phases with sufficient accuracy. The whole text is based on the fact that 25 Egyptian years cover the same time interval as 309 lunations. The 25 years equal 9125 days, which are periodically arranged into groups of lunar months of 29 and 30 days. The periodic repetition of this simple scheme corresponds, on the average, very well with the facts; more was apparently not required, and, we may add, more was not obtainable with the available simple mathematical means which are described at the beginning of this section. The purpose of the text was to locate the wandering lunar festivals within the schematic civil calendar, as is shown by a list of the "great" and "small" years of the cycle, which contain 13 or 12 lunar festivals, respectively.[25] Accordingly, calendaric problems are seen to be the activating forces here as well as in the decanal lists of the Middle and New Kingdom. The two Carlsberg papyri thus give us a very consistent picture of Egyptian stellar and lunar astronomy and its calendaric relations and are in best agreement with the level known from the mathematical papyri.

Before leaving the description of Egyptian science, brief mention should be made of the much-discussed question of the "scientific" character of Egyptian mathematics and astronomy. First of all, the word "scientific" must be clearly defined. The usual identification of this question with that of the practical or theoretical purpose of our documents is obviously unsatisfactory. One cannot call medicine or physics unscientific even if they serve eminently practical purposes. It is neither possible nor relevant to discover the moral motives of a scientist—they might be altruistic or selfish, directed by the desire for systematization or by interest in competitive success. It is therefore clear that the concept "scientific" must be described as a question of methods, not of motives. In the case of mathematics and astronomy, the situation is especially simple. The criterion for scientific mathematics must be the existence of the concept of proof; in astronomy, the elimination of all arguments which are not exclusively based on observations or on mathematical consequences of an initial hypothesis as to the fundamental character of the movements involved. Egyptian mathematics nowhere reaches the level of argument which is worthy of the name of proof, and even the much more highly developed Babylonian mathematics hardly ever displays a general technique for proving its procedures.[26]

[25] The "great" and "small" years (already mentioned in an inscription of the Middle Kingdom) have given rise to much discussion (cf., e.g., Ginzel *Chron.*, I, pp. 176–77) which can now be completely ignored.

[26] See the discussion in Neugebauer *Vorl.*, pp. 203 ff.

Egyptian astronomy was satisfied with a very rough qualitative description of the phenomena—here, too, we miss any trace of scientific method. The first scientific attack of mathematical problems was made in the fifth century B.C. in Greece. We shall see that scientific astronomy can be found shortly thereafter in Babylonian texts of the Seleucid period. In other words, the enormous interest of the study of pre-Hellenistic Oriental sciences lies in the fact that we are able to follow the development far back into *pre*-scientific periods which saw the slow preparation of material and problems which deeply influenced the shape of the real scientific methods which emerged to full power for the first time in the Hellenistic culture. It is a serious mistake to try to invest Egyptian mathematical or astronomical documents with the false glory of scientific achievements or to assume a still unknown science, secret or lost, not found in the extant texts.

III. MESOPOTAMIA

7. Turning to Babylonian astronomy, one's first impression is that of an enormous contrast to Egyptian astronomy. This contrast not only holds in regard to the large amount of material available from Mesopotamia but also with respect to the level finally reached. Texts from the last two or three centuries B.C. permit the computation of the lunar movement according to methods which certainly rank among the finest achievements of ancient science—comparable only to the works of Hipparchus and Ptolemy.

It is one of the most fascinating problems in the history of ancient astronomy to follow the different phases of this development which profoundly influenced all further events. Before giving a short sketch of this progress as we now restore it according to our present knowledge, we must underline the incompleteness of the present state of research, which is due to the fact that we do not yet have reliable and complete editions of the text material. The observation reports addressed to the Assyrian kings were collected by R. C. Thompson[27] and in the editions of Assyrian letters published and translated by Harper,[28] Waterman,[29] and Pfeiffer;[30] much related material is quoted in the publications of Kugler,[31] Weidner,[32] and others. But Thompson's edition gives the original texts only in printed type, subject to all the misunderstandings of this early period of Assyriology, and very little has been done to repair these original errors. Nothing short of a systematic "corpus" of all the relevant texts can provide us with the requisite security for systematic interpretation. The great collection of astrological texts, undertaken by Virolleaud[33] but never finished, confronts the reader with still greater difficulties, because Virolleaud composed complete versions from various fragments and duplicates without indicating the sources from which the different parts came. And, finally, the tablets dealing with the movement of the moon and the planets were discussed and explained in masterly fashion by Kugler;[34] but here, too, a systematic edition of the whole material is necessary.[35] Years of systematic work will be needed before the foundations for a reliable history of the development of Babylonian astronomy are laid.

8. Kugler uncovered step by step the ingenious methods by which the ephemer-

[27] Thompson *Rep.* (1900).
[28] Harper *Letters*.
[29] Waterman *RC*.
[30] Pfeiffer *SLA*.
[31] Kugler *SSB* and Kugler *MP*.
[32] Weidner *Hdb.*, Weidner [1], [2], and numerous articles in the pre-war volumes of *Babyloniaca*.
[33] Virolleaud *ACh*.
[34] Kugler *BMR* and *SSB*.
[35] Such an edition by the present author is in preparation; it is quoted in the following as *ACT*.

ids of the moon and the planets which we find inscribed on tablets ranging from 205 B.C. to 30 B.C. were computed.[36] It can justly be said that his discoveries rank among the most important contributions toward an understanding of ancient civilization. It is very much to be regretted that historians of science often quote Kugler but rarely read him;[37] by doing this, they have disregarded the newly gained insight into the origin of the basic methods in exact science. This is not the place to describe in detail the Babylonian "celestial mechanics," as it might properly be called; that will be one of the tasks of a history of ancient astronomy which remains to be written. A few words, however, must be said in order to render intelligible the relationship between Babylonian and Greek methods. The problem faced by ancient astronomers consisted in predicting the positions of the moon and the planets for an extended period of time and with an accuracy higher than that obtainable by isolated individual observations, which were affected by the gross errors of the instruments used. All these phenomena are of a periodic character, to be sure, but are subject to very complicated fluctuations. All that we know now seems to point to the following reconstruction of the history of late Babylonian astronomy. A systematic observational activity during the Late Assyrian and Persian periods (roughly, from 700 B.C. onward) led to two different results. First, the collected observations provided the astronomers with fairly accurate average values for the main periods of the phenomena in question; once such averages were obtained, improvements could be furnished by scattered observational records from preceding centuries. Secondly, from individual observations, for example, of the moment of full moon[38] or of heliacal settings, etc., short-range predictions could be made by methods which we would call linear extrapolation. Such methods are frequently sufficient to *exclude* certain phenomena (such as eclipses) in the near future and, under favorable conditions, even to predict the date of the next phenomenon in question. After such methods had been developed to a certain height, apparently one ingenious man conceived a new idea which rapidly led to a systematic method of long-range prediction. This idea is familiar to every modern scientist; it consists in considering a complicated periodic phenomenon as the result of a number of periodic effects, each of a character which is simpler than the actual phenomenon.[39] The whole method probably originated in the theory of the moon, where we find it at its highest perfection. The moments of new moons could easily be found if the sun and moon would each move with constant velocity. Let us assume this to be the case and use average values for this ideal movement; this gives us average positions for the new moons. The actual movement deviates from this average but oscillates around it periodically. These deviations were now treated

[36] The first tentative (but very successful) steps were made by Epping *AB* (1889). Then follow Kugler's monumental works *BMR* (1900) and *SSB* (published between 1907 and 1924), supplemented by Schaumberger's explanation of the determination of first and last visibility of the moon (1935) and continued by the present author with respect to the theory of latitude and eclipses (Neugebauer [8], [9], Pannekoek [2] and van der Waerden [1]). The theory of planets is treated in Kugler *SSB*, to be supplemented by Pannekoek [1], Schnabel [2], and van der Waerden [2]. All previously published texts and much unpublished material will be contained in Neugebauer *ACT*. The whole material amounts to about a hundred ephemerids for the moon and the planets, covering the abovementioned two centuries.

[37] Abel Rey, *La Science orientale avant les grecs* (Paris, 1930), and E. Zinner, *Geschichte der Sternkunde* (Berlin, 1931), are brilliant examples showing complete ignorance of Kugler's results.

[38] Frequently mentioned in the "reports" to the Assyrian court (e.g., Thompson *Rep.*).

[39] A classic example is the treatment of sounds as the result of the superposition of pure harmonic vibrations.

as new periodic phenomena and, for the sake of easier mathematical treatment, were considered as linearly increasing and decreasing. Additional deviations are caused by the inclination of the orbits. But here again a separate treatment, based on the same method, is possible. Thus, starting with average positions, the corrections required by the periodic deviations are applied and lead to a very close description of the actual facts. In other words, we have here, in the nucleus, the idea of "perturbations," which is so fundamental to all phases of the development of celestial mechanics, whence it spread into every branch of exact science.

We do not know when and by whom this idea was first employed. The consistency and uniformity of its application in the older of the two known "systems" of lunar texts point clearly to an invention by a single person. From the dates of the preserved texts, one might assume a date in the fourth or third century B.C.[40] This basic idea was applied not only to the theory of the moon (in two slightly modified forms) but also to the theory of the planets. In this latter theory the main point consists in refraining from an attempt to describe directly the very irregular movement, substituting instead the separate treatment of several individual phenomena, such as opposition, heliacal rising, etc.; each of these phenomena is treated with the methods familiar from the lunar theory as if it were the periodic movement of an independent celestial body. After dates and positions of each characteristic phenomenon are determined, the intermediate positions are found by interpolation between these fixed points.[41] It must be said, however, that the planetary theory was not developed to the same degree of refinement as the lunar theory; the reason might very well be that the lunar theory was of great practical importance for the question of the Babylonian calendar: whether a month would have 30 or 29 days. For the planets no similar reason for high accuracy seems to have existed, and it was apparently sufficient merely to compute the approximate dates of phenomena, which, in addition, are frequently very difficult to observe accurately.

We cannot emphasize too strongly that the essential point in the above-described methods lies not in the comparatively high accuracy of the results obtained but in their fundamentally new attitude toward the whole problem. Let us, as a typical example, consider the movement of the sun.[42] Certain simple observations, most likely of the unequal length of the seasons, had led to the discovery that the sun does not move with constant velocity in its orbit. The naïve method of taking this fact into account would be to compute the position of the sun by assuming a regularly varying velocity. It turned out, however, that considerable mathematical difficulties were met in computing the syzygies of the moon according to such an assumption. Consequently, another velocity distribution was substituted, and it was found that the following "model" was satisfactory: the sun moves with two different velocities over two unequal arcs of the ecliptic, where velocities and arcs were determined in such a fashion that the initial empirical facts were correctly explained and at the same time the computation of the conjunctions became suffi-

[40] The attempts to determine a more precise date (Schnabel *Ber.*, pp. 219 ff., and Schnabel [1], pp. 15 ff.) are based on unsatisfactory methods. The generally accepted statement that Naburimannu was the founder of the older system of the lunar theory relies on nothing more than the occurrence of this name in one of the latest tablets in a context which is not perfectly clear.

[41] This is shown by a tablet for Mercury, to be published in Neugebauer *ACT*. The interpolation is not simply linear but of a more complicated type known from analogous cases in the lunar theory.

[42] For details see Neugebauer [10] and [9] § 2.

ciently simple. It is self-evident that the man who devised this method did not think that the sun moved for about half a year with constant velocity and then, having reached a certain point in the ecliptic suddenly started to move with another, much higher velocity for the rest of the year. His problem was clearly this: to make a very complicated problem accessible to mathematical treatment with the only condition that the final consequences of the computations correctly correspond to the actual observations—in our example, the inequality of the seasons. The Greeks[43] called this a method "to preserve the phenomena"; it is the method of introducing mathematically useful steps which in themselves need not be of any physical significance. For the first time in history, mathematics became the leading principle for the structure of physical theories.

9. It will be clear from this discussion that the level reached by Babylonian mathematics was decisive for the development of such methods. The determination of characteristic constants (e.g., period, amplitude, and phase in periodic motions) not only requires highly developed methods of computation but inevitably leads to the problem of solving systems of equations corresponding to the outside conditions imposed upon the problem by the observational data. In other words, without a good stock of mathematical tools, devices of the type which we find everywhere in the Babylonian lunar and planetary theory could not be designed. Egyptian mathematics would have rendered hopeless any attempt to solve problems of the type needed constantly in Babylonian astronomy. It is therefore essential for our topic to give a brief sketch of Babylonian mathematics.

I think it can be justly said that we have a fairly good knowledge of the character of mathematical problems and methods in the Old Babylonian period (*ca.* 1700 B.C.). Almost a hundred tablets from this period are published;[44] they contain collections of problems or problems with complete solutions—amounting to far beyond a thousand problems. We know practically nothing about the Sumerian mathematics of the previous periods and very little of the interval between the Old Babylonian period and Seleucid times. We have but few problem texts from the latter period, but they give us some idea of the type of mathematics familiar to the astronomers of this age. This material is sufficient to assure us that all the essential achievements of Old Babylonian times were still in the possession of the latest representatives of Mesopotamian science. In other words, Babylonian mathematical astronomy was built on foundations independently laid more than a millennium before.

If one wishes to characterize Babylonian mathematics by one term, one could call it "algebra." Even where the foundation is apparently geometric, the essence is strongly algebraic, as can be seen from the fact that frequently operations occur which do not admit of a geometric interpretation, as addition of areas and lengths, or multiplication of areas. The predominant problem consists in the determination of unknown quantities subject to given conditions. Thus we find prepared precisely the tools which were later to become of the greatest importance for astronomy.

Of course, the term "algebra" does not completely cover Babylonian mathemat-

[43] E.g., Proclus, *Hypotyposis astron. pos.* v. 10 (ed. Manitius, 140, 21).

[44] These texts were published in Neugebauer *MKT* (1935–38) and in Neugebauer-Sachs *MCT* (1945). A large part of the *MKT* material was republished in Thureau-Dangin *TMB* (1939). For a general survey see Neugebauer *Vorl.*

ics. Not only were a certain number of geometrical relations well known but, more important for our problem, the basic properties of elementary sequences (e.g., arithmetic and geometric progressions) were developed.[45] The numerical calculations are carried out everywhere with the greatest facility and skill.

We possess a great number of texts from all periods which contain lists of reciprocals, square and cubic roots, multiplication tables, etc., but these tables rarely go beyond two sexagesimal places (i.e., beyond 3600). A reverse influence of astronomy on mathematics can be seen in the fact that tables needed for especially extensive numerical computations come from the Seleucid period; tables of reciprocals are preserved with seven places (corresponding to eleven decimal places) for the entry and up to seventeen places (corresponding to twenty-nine decimal places) for the result. It is clear that numerical computations of such dimensions are needed only in astronomical problems.

The superiority of Babylonian numerical methods has left traces still visible in modern times. The division of the circle into 360 degrees and the division of the hour into 60 minutes and 3600 seconds reflect the unbroken use of the sexagesimal system in their computations by medieval and ancient astronomers. But though the base 60 is the most conspicuous feature of the Babylonian number system, this was by no means essential for its success. The great number of divisors of 60 is certainly very useful in practice, but the real advantage of its use in the mathematical and astronomical texts lies in the place-value notation,[46] which is consistently employed in all scientific computations. This gave the Babylonian number system the same advantage over all other ancient systems as our modern place-value notation holds over the Roman numerals. The importance of this invention can well be compared with that of the alphabet. Just as the alphabet eliminates the concept of writing as an art to be acquired only after long years of training, so a place-value notation eliminates mere computation as a complex art in itself. A comparison with Egypt or with the Middle Ages illustrates this very clearly. Operation with fractions, for example, constituted a problem in itself for medieval computers; in place-value notation, no such problem exists,[47] thus eliminating one of the most serious obstacles for the further development of mathematical technique.

The analogy between alphabet and place-value notation can be carried still further. Neither one was the sudden invention made by a single person but the final outcome of various historical processes. We are able to trace Mesopotamian number-writing far back into the earliest stages of civilization, thanks to the enormous amount of economic documents preserved from all periods. It can be shown how a notation analogous to the Egyptian or Roman system was gradually replaced by a notation which developed naturally in the monetary system and which tended toward a place-value notation. The value 60 of the base appears to be the outcome of the arrangement of the monetary

[45] Incidentally, we also have an example (Neugebauer-Sachs *MCT*, Problem-Text A) of purely number theoretical type from Old Babylonian times (so-called "Pythagorean numbers"); but it should be added that we do not find the slightest trace of number mysticism anywhere in these texts.

[46] Place-value notation consists in the use of a very limited number of symbols whose magnitude is determined by position. Thus 51 does not mean 5 plus 1 (as it would with Roman or Egyptian numerals), but 5 times 10 plus 1. Analogously in the sexagesimal system, five followed by one (we transcribe 5,1) means 5 times 60 plus 1 (i.e., 301).

[47] Example: to add or to multiply 1.5 and 1.2 requires exactly the same operations as the addition or multiplication of 15 and 12.

units.[48] Outside of mathematical texts, the place-value notation was always overlapped by various other notations, and toward the end of Mesopotamian civilization a modified system became predominant. It seems very possible, however, that the idea of place-value writing was never completely lost and found its way through astronomical tradition into early Hindu astronomy.[49] whence our present number system originated during the first half of the first millennium A.D.

10. We now turn to the periods preceding the final stage of Babylonian astronomy which culminated in the mathematical theory of the moon and the planets described above. It is not possible to give an outline of this earlier development because most of the preliminary work remains to be done. A few special problems, however, which must eventually find their place in a more complete picture, can now be mentioned.

In our discussion of the methods used in the lunar and planetary theories, we had occasion to mention the extensive use of periodically increasing and decreasing sequences of numbers. A simple case of this method appears in earlier times in the problem of describing numerically the changing length of day and night during the year. The crudest form is the assumption of linear variation between two extremal values.[50] Two much more refined schemes are incorporated in the texts of the latest period, but it seems very likely that they are of earlier origin. Closely related are two other problems: the variability of the length of the shadow of the "gnomon"[51] and the measurement of the length of the day by water clocks.[52] The latter problem has caused considerable trouble in the literature on the subject because the texts show the ratio 2:1 for the extremal values during the year. A ratio 2:1 between the longest and the shortest day, instead of the ratio 3:2, which is otherwise used,[53] would correspond to a geographical latitude absolutely impossible for Babylon. The discrepancy disappears, however, if one recalls the fact that the amount of water flowing from a cylindrical vessel is not proportional to the time elapsed but decreases with the sinking level.[54] It is worth mentioning in this connection that the outflow of water from a water clock is already discussed in Old Babylonian mathematical texts.[55] This whole group of texts, however, leads to nothing more than very approximate results. This is seen from the fact that the year is assumed, for the sake of simplicity, to be 360 days long and divided into 12 months of 30 days each.[56] This schematic treatment has its parallel in the schemes which we have met in Egyptian astronomy and which we shall find again in early Greek astronomy; we must once more emphasize that elements from such schemes cannot be used for modern calculations, since this would assume quantitative accuracy where only qualitative results had been intended.

The calendaric interest of these problems is obvious. The same is true of the

[48] For details see Neugebauer [11] and Neugebauer *Vorl.*, chap. iii § 4. The theory set forth by Thureau-Dangin *SS* (English version Thureau-Dangin [1]) does not account for the place-value notation, which is the most essential feature of the whole system.

[49] Cf. Datta-Singh *HHM* I and Neugebauer [12], pp. 266 ff.

[50] E.g., Weissbach *BM*, pp. 50–51.

[51] Weidner [1], pp. 198 ff.

[52] Weissbach *BM*, pp. 50–51; Weidner [1], pp. 195–96.

[53] Schaumberger *Erg.*, p. 377.

[54] Neugebauer [19].

[55] Thureau-Dangin [2] and Neugebauer *MKT*, I, pp. 173 ff.

[56] This schematic year of 360 days, of course, does not indicate that one assumed 360 days as the correct length of the solar year. A lunar calendar makes correct predictions of a future date very difficult. The schematic calendar is in practice therefore very convenient for giving future dates which must, at any rate, be adjusted later.

oldest preserved astronomical documents from Mesopotamia, the so-called "astrolabes."[57] These astrolabes are clay tablets inscribed with a figure of three concentric circles, divided into twelve sections by twelve radii. In each of the thirty-six fields thus obtained we find the name of a constellation and simple numbers whose significance is not yet clear. But it seems evident that the whole text constitutes some kind of schematic celestial map which represents three regions on the sky, each divided into twelve parts, and attributing characteristic numbers to each constellation. These numbers increase and decrease in arithmetic progression and are undoubtedly connected with the corresponding month of the schematic twelve-month calendar. It is clear that we have here some kind of simple astronomical calendar parallel (not in detail, but in purpose) to the "diagonal calendars" in Egypt. In both cases these calendars are of great interest to us as a source for determining the relative positions and the earliest names of various constellations. But here, too, the strongest simplifications are adopted in order to obtain symmetric arrangements, and much remains to be done before we can answer such questions as the origin of the "zodiac."

11. Few statements are more deeply rooted in the public mind or more often repeated than the assertion that the origin of astronomy is to be found in astrology. Not only is historical evidence lacking for this statement but all well-documented facts are in sharp contradiction to it. All the above-mentioned facts from Egypt and Babylonia (and, as we shall presently see, also from Greece) show that calendaric problems directed the first steps of astronomy. Determination of the season, measurement of time, lunar festivals—these are the problems which shaped astronomical development for many centuries; and we have seen that even the last phase of Mesopotamian astronomy, characterized by the mathematical ephemerids, was mainly devoted to problems of the lunar calendar. It is therefore one of the most difficult problems in the history of ancient astronomy to uncover the real roots of astrology and to establish their relation to astronomy. Very little has been done in this direction, mainly because of the prejudice in favor of accepting without question the priority of astrology.

Before going into this problem in greater detail, we must clarify our terminology. The modern reader usually thinks in terms of that concept of astrology which consists in the prediction of the fate of a person determined by the constellation of the planets, the sun, and the moon at the moment of his birth. It is well known, however, that this form of astrology is comparatively late and was preceded by another form of much more general character (frequently called "judicial" astrology in contrast to the "genethlialogical" or "horoscopic" astrology just described). In judicial astrology, celestial phenomena are used to predict the imminent future of the country or its government, particularly the king. From halos of the moon, the approach or invisibility of planets, eclipses, etc., conclusions are drawn as to the invasion of an enemy from the east or west, the condition of the coming harvest, floods and storms, etc.; but we never find anything like the "horoscope" based on the constellation at the moment of birth of an individual. In other words, Mesopotamian "astrology" can be much better compared with weather prediction from phenomena observed in the skies than with astrology in the modern sense of the

[57] This name is rather misleading and is merely due to the circular arrangement. Schott [1], p. 311, introduced the more appropriate name "twelve-times-three." Such texts are published in CT 33, Pls. 11 and 12. Cf. also Weidner *Hdb.*, pp. 62 ff. and Schott [1].

word. Historically, astrology in Mesopotamia is merely one form of predicting future events; as such, it belongs to the enormous field of omen literature which is so familiar to every student of Babylonian civilization.[58]

Indeed, it can hardly be doubted that astrology emerged from the general practice of prognosticating through omens, which was based on the concept that irregularities in nature of any type (e.g., in the appearance of newborn animals or in the structure of the liver or other internal parts of a sheep) are indicative of other disturbances to come. Once the idea of fundamental parallelism between various phenomena in nature and human life is accepted, its use and development can be understood as consistent; established relations between observed irregularities and following events, constantly amplified by new experiences, thus lead to some sort of empirical science, which seems strange to us but was by no means illogical and bare of good sense to the minds of people who had no insight into the physical laws which determined the observed facts.

Though the preceding remarks certainly describe the general situation adequately, the historical details are very much in the dark. One of the main difficulties lies in the character of our sources. We have at our disposal large parts of collections of astrological omens arranged in great "series" comprising hundreds of tablets. But the preserved canonical series come mainly from comparatively late collections (of the Assyrian period) and were thus undoubtedly subject to countless modifications. We must, moreover, probably assume that the collection of astrological omina goes back to the Cassite period (before 1200 B.C.)—a period about which our general information is pretty flimsy. From the Old Babylonian period only one isolated text is preserved[59] which contains omina familiar from the later astrology. Predictions derived from observations of Venus made during the reign of Ammiṣaduqa (*ca.* 1600 B.C.) are preserved only in copies written almost a thousand years later[60] and clearly subjected to several changes during this long time. We are thus again left in the dark as to the actual date of the composition of these documents except for the fact that it seems fairly safe to say that no astrological ideas appear before the end of the Old Babylonian period. Needless to say, there are no astrological documents of Sumerian origin.

The period of the ever increasing importance of astrology (always, of course, of the above-mentioned type of "judicial" astrology) is that beginning with the Late Assyrian empire. The "reports" mentioned previously, preserved in the archives of the Assyrian kings, are our witnesses. But here, again, a completely unsolved problem must be mentioned: we do not know how the "horoscopic" astrology of the Hellenistic period originated from the totally different omen type of astrology of the preceding millennium. It is, indeed, an entirely unexpected turn to make the constellation of the planets at a single moment responsible for the whole future of an individual, instead of observing the ever shifting phenomena on the sky and thus establishing short-term consequences for the country in general (even if represented in the person of the king). It seems to me by no means self-evident that this radical shift of the character of astrology actually originated in Babylonia. We shall see in the next section that the horoscopic practice flourished especially in Egypt. It might therefore very well be that the new tendency originated in Hellenistic times

[58] A comprehensive study of the development of the astrological omina literature by E. F. Weidner is in course of publication (Weidner [2]).

[59] Šileiko [1]. [60] Langdon *VT*.

outside Mesopotamia and was reintroduced there in its modified form. It might be significant that only seven horoscopes are preserved from Mesopotamia, all of which were written in the Seleucid period,[61] a ridiculously small number as compared with the enormous amount of textual material dealing with the older "judicial" astrology. It must be admitted, however, that the oldest horoscopes known are of Babylonian origin. On the other hand, at no specific place can all the elements be found which are characteristic for astrology from Hellenistic times onward. Neither Babylonian astrology nor Egyptian cosmology furnishes the base for the fundamental assumption of horoscopic astrology, namely, that the position of the planets in the zodiac decides the future. And, finally, it must be emphasized that the problem of determining the date and place of origin of horoscopic astrology is intimately related to the problem of the date and origin of mathematical astronomy. Horoscopes could not be cast before the existence of methods to determine the position of the celestial bodies for a period of at least a few decades. Even complete lists of observations would not be satisfactory because the positions of the planets in the zodiac are required regardless of their visibility at the specific hour. This shows how closely interwoven are the history of astrology and the history of planetary theories.

IV. THE HELLENISTIC PERIOD

12. Before beginning the discussion of the Hellenistic period, we must briefly describe the preceding development in Greece. Our direct sources of information about astronomy and mathematics before Alexander are extremely meagre. The dominating influence of Euclid's *Elements* succeeded in destroying almost all references to pre-Euclidean writings, and essentially the same effect was produced by Ptolemy's works. Original documents are, of course, not preserved—one must not forget that even our oldest manuscripts of Greek mathematical and astronomical literature were written many centuries after the originals.[62] It is therefore not surprising that our present-day knowledge of early Greek science is much more incomplete and subject to conjecture than the history of Mesopotamian or even Egyptian achievements where original documents are at our disposal. One point, however, can be established beyond any doubt: early Greek astronomy shows very strong parallelism with the early phases of Egyptian and Babylonian astronomy, with respect to scope as well as primitiveness. The astronomical writings of Autolycus[63] and Euclid[64] struggle in a very crude way with the problem of the rising and setting of stars, making very strong simplifications which were forced upon them by the lack of adequate methods in spherical geometry. The final goal is again to establish relations between the celestial phenomena and the seasons of the years; the problem is thus of essentially calendaric interest. In addition to these simple treatises, however, we do find one work of outstanding character: the planetary theory of Eudoxos, Plato's famous contemporary. He made an attempt to explain the peculiarities of a planetary movement known as retrogra-

[61] Two are published by Kugler *SSB*, II, 554 ff., and refer to the years 258 and 142 B.C., respectively. One (probably 233 B.C.) is published in Thompson *AB* 251. Among four unpublished horoscopes, discovered by Dr. A. Sachs, two are very small fragments, one can be dated 235 B.C., and the last was cast for the year 263 B.C.; the last is the oldest horoscope in the world.

[62] The oldest preserved manuscript of Euclid's *Elements* was written about twelve hundred years after Euclid (cf., e.g., Heath *Euclid*, I, p. 47).

[63] Autolycus, ed. Hultsch (Leipzig, 1885).

[64] *Euclidis opera omnia*, Vol. VIII, ed. Menge (Leipzig, 1916).

dation by the assumption of the superposition of the rotation of two concentric spheres around inclined axes and in opposite directions. In this way he reached a satisfactory explanation of the general type of planetary movement and thereby inaugurated a new period in the history of astronomy which was marked by attempts to explain the movements of the planetary system by mechanical models. It contains the nucleus for all planetary theories of the following two thousand years, namely, the assumption that irregularities in the apparent orbits can be explained as the result of superposed circular movements. It is only since Galileo and Newton that we know that the circular orbits do not play an exceptional role and that the great successes of the Greek theory were merely due to the accidental distribution of masses in our planetary system. It is, nevertheless, of great historical interest to see how a plausible initial hypothesis can for many centuries determine the line of attack on a problem, simultaneously barring all other possibilities. Such possibilities were actually contained in the approach developed by the Babylonian astronomers in the idea of superposing linear or quadratic periodic functions. These arithmetical methods were, however, almost completely abandoned by the Greek astronomers (at least so far as we know) and survived only in the treatment of certain smaller problems.

One of these smaller problems is again related to calendaric questions but also to a basic problem of mathematical geography: the determination of the geographical latitude by means of the ratio of the longest to the shortest day. We have already mentioned the Babylonian methods of describing the change in the length of the days by means of simple sequences. These "linear" methods reappear in Greek literature and can be followed far into the early Middle Ages[65] in spite of the invention of much more accurate methods.[66] The term "linear" does not refer so much to the fact that the sequences in question form arithmetic progressions of the first order but is intended to emphasize the contrast with the "trigonometric" method applied to the same problem and explained in the first book of the *Almagest*. Here the exact solution of the problem by the use of spherical trigonometry is given. In contrast thereto, the linear methods yield only approximate results, but with an accuracy which was certainly sufficient in practice, especially when one takes into account the inaccuracy of the ancient instruments used in measuring time. Historically, however, the main interest lies much less in the perfection of the results than in the method employed and in its influence on the further development. A close investigation of early Greek astronomy and mathematics[67] reveals an interesting fact. The determination of the time for the rising and setting of given arcs of the ecliptic, which lies at the heart of the question of the changing length of day and night, appears to be the most decisive problem in the development of spherical geometry. It is typical for the whole situation that a Greek "mathematical" work, the *Sphaerics* of Theodosius (*ca.* 200 B.C.), does not contain a single astronomical remark. The structure and contents of the main theorems, however, are determined by the astronomical problem in question; the methods applied constitute a very interesting link between the Babylonian linear methods and the final trigonometrical methods.

Trigonometry undoubtedly has a very

[65] Neugebauer [13] and [18].

[66] *Almagest* II, 7 and 8. Cf. also *Tetrabiblos* I, 20 (ed. Robbins, p. 94), 21 (ed. Boll-Boer, pp. 46, 47 ff.).

[67] This investigation has been carried out by Olaf Schmidt (doctoral thesis, Brown Univ., 1943 [unpublished]).

long history. We find the basic relations between the chord and diameter of a circle already in use in Old Babylonian texts which employ the so-called "Thales" and "Pythagorean" theorems.[68] In sharp contrast to the Greek models for the movement of the celestial bodies, which operate with circles and therefore necessarily require trigonometrical functions, we find no applications of trigonometry in the cuneiform astronomical texts of the Seleucid period which are exclusively based on arithmetical methods described above.

So far as we know, spherical trigonometry appears for the first time in the *Sphaeric* of Menelaos[69] (*ca.* A.D. 100). The astronomical background of this work is much more outspoken than in Theodosius, but here, too, much is left to the reader, who must be familiar with the methods of ancient astronomy to understand all the astronomical implications. The modern scholar faces an additional difficulty, namely, the modification of the Greek text by the Arabic editors. The Greek original is lost, and what we possess is only the Arabic version made almost a thousand years later. In this interval falls the gradual transformation of Greek trigonometry, operating with chords, to the modern treatment, which uses the sine function. It is well known that this change goes back to Hindu astronomy, where the chords subtended by an angle were replaced by the length of the half-chord of the half-angle,[70] i.e., our "sin α." It is, however, a much more involved question to separate these new methods from those used originally by Menelaos; this question must be answered if we wish to understand the development of ancient spherical astronomy. This, in turn, is necessary in order to appreciate the contributions made by the Hindu-Arabic astronomers which eventually led to the modern form of spherical trigonometry.

13. It is of great interest to see that the very same problem—the determination of rising times—leads to still other methods which are now known partly as "nomography," partly as "descriptive geometry." We have a small treatise, written by Ptolemy, called the *Analemma*.[71] He first introduces in a very systematic way three different sets of spherical coordinates, each of which determines the position of a point on the celestial sphere. Then these coordinates are projected on different planes, and these planes are turned into the plane of construction, just as we do today in descriptive geometry. Finally, certain scales are used to find graphically the relations between different coordinates, again following principles which we now use in nomography. The Arabs used and developed these methods in connection with the construction of sundials.[72] Another method of projection, today called "stereographic," is given in Ptolemy's *Planisphaerium*. The theory of perspective drawing in the Renaissance is directly connected with this work.[73]

The practical importance of the determination of the rising times or the length of the days is not restricted to the theory of sundials. The length of the longest day increases with the geographical latitude, thus giving us the means to determine the latitude of a place from the ratio of the

[68] Cf. Neugebauer-Struve [1], pp. 90–91; Neugebauer *MKT*, I, p. 180; and Neugebauer-Sachs *MCT*, Problem-Text A.

[69] Krause *Men.*

[70] Cf., e.g., Braunmühl *GT*, chap. 3.

[71] Ptolemy, *Opera* II, pp. 187–223. No complete translation of this badly preserved text has yet been published, but an excellent commentary has been given by Luckey [1]. These methods, using descriptive geometry, are of an older date, as is evident from the fact that they are already mentioned by Vitruvius (beginning of our era). Cf. Neugebauer [14] and Luckey [2].

[72] Cf., e.g., Garbers *ES* and Luckey [2].

[73] Ptolemy, *Opera* II, pp. 225–59, translated in Drecker [1]; cf. also Loria in M. Cantor, *Geschichte der Mathematik*, IV, p. 582.

shortest to the longest day. The ratio 3 : 2 accepted by Babylonian astronomers for the ratio of the longest to shortest daylight led the Greek geographers to determine erroneously the latitude of Babylon as 35° (instead of 32½°). This error seriously affected the shape of the eastern part of the ancient map of the world.[74] The precise relationship can only be established by using spherical trigonometry, but here, too, the "linear" methods were applied to various values of the basic ratio in order to give the law for the changing length of the days for the corresponding latitude. It must be remarked, however, that at this stage of affairs the concept "latitude" does not yet actually appear, but the ratio of the longest to the shortest day itself was used to characterize the location of a place. Zones of the same ratio were considered as belonging to the same "clima," a concept which plays a great role in ancient and medieval geography. The difference in character and behavior of nations living in different climates furnished one of the main arguments for the influence of astronomical phenomena on human life.[75]

The second geographical coordinate—the longitude—caused more trouble. The difference in longitude between two places on the earth is essentially equivalent to the difference in local time. But there existed no clocks or signals to compare the local time at far-distant places. Only one phenomenon could be used as a time signal, namely, records of simultaneous observations of a lunar eclipse from two different places. If each observer took note of the local time at which he observed the beginning and end of a lunar eclipse, a comparison of these records would then furnish the needed information. Hipparchus proposed the use of this method for an exact construction of the map of the world, but his program was never carried out. Only one pair of simultaneous observations seems to have been made, the eclipse of 331 B.C., September 20, recorded three hours earlier in Carthage than at Arbela.[76] Actually the difference in local time between these two localities is much smaller, and consequently the ancient map of the world suffers from a serious distortion in the direction from east to west. Here we see one of the most essential differences between ancient and modern science at work. Ancient science suffered most severely from the lack of scientific organization which is so familiar in our own times. In antiquity, generations passed before a new scientific idea found a follower able to use and develop methods handed down from a predecessor. The splendid isolation of the great scholars of antiquity can only be paralleled with the first beginnings of the new development in the European Renaissance. It seems to me beyond any doubt that even centers like Alexandria or Pergamon during their height would appear very poorly equipped if compared with a modern university of moderate size. And these centers themselves were few and practically isolated at any particular time; and at all times they were dependent upon the mood of some autocratic ruler. No wonder that the great achievements of antiquity are either the result of priestly castes of sufficiently stable tradition or of a few ingenious men who expended tremendous energy in restoring and enlarging the structure of a science known to them from the written legacy of their predecessors. One must not think

[74] For the determination of the size of the earth by Eratosthenes (about 250 B.C.), Marinus of Tyre (about A.D. 100), and Ptolemy (about A.D. 150), see Mžik *EGM*, pp. 96 ff., and, in general, Heidel *GM*, chap. xi. Cf. also Honigmann *SK* and Neugebauer [13].

[75] E.g., *Tetrabiblos* II, 2.

[76] Ptolemy *Geographia* I. 4. 2 (ed. Nobbe, p. 11). Cf. also Mžik-Hopfner *PDE*, p. 21, n. 3. For Hipparchus' program see Strabo *Geography* I. C. 7; also Berger *GFH*, pp. 12 ff.

that mathematics and astronomy, like the popular philosophical systems or the art of rhetoric, were taught in the same manner from generation to generation. Three centuries separate Hipparchus from Ptolemy, one Eudoxos from Euclid, Euclid from Archimedes and Apollonius. To be sure, the literary tradition was never interrupted between these outstanding men, but most of the intermediate literature at best merely preserved and commented. This explains not only why ingenious ideas were frequently lost (e.g., Archimedes' methods of integration) but also why it was so easy to destroy ancient science almost completely in a very short time. Astronomy alone had a slight advantage because of its practical usefulness in navigation, geography, and time-reckoning, supplemented by the fortunate accident that the Easter festival followed the lunar calendar of the Near East, thus sanctioning lunar theory when other secular sciences fell into total desuetude.

The extreme paucity of scientists at almost any given time in antiquity gave rise to another phenomenon in Greek literature: the publication of commentaries and popularizing works. A work like the *Almagest*, written in purely scientific style, was certainly unintelligible to the majority of people who needed or wanted to know a modest amount of astronomy. Hence books were written which attempted to explain Ptolemy's text sentence by sentence,[77] or which gave abstracts accompanied by explanations of the main principles as far as this could be done without mathematics.[78] We can observe the same phenomenon in geography. The first chapter of Ptolemy's *Geography*[79] contains a very interesting theory of map projection, whereas the remaining twelve chapters constitute an enormous catalogue of localities from all over the then known world and the corresponding values of longitude and latitude to be plotted into the network which was to be constructed according to the method explained in the first chapter. This, again, was not geography for the entertainment of the general reader. To satisfy popular tastes, there was another literature, represented by works like Strabo's *Geography*.[80] These more pleasant writings furnished serious competition to the strictly scientific literature and determined to a large extent the character of the field in late antiquity and the Middle Ages.

14. For the modern historian of ancient astronomy it is therefore of the greatest value to have an additional source of astronomical literature in which the earlier tradition was kept alive without interruption for a much longer period: the astrological texts. We have already mentioned that astrology in the modern use of the word appeared very late in antiquity. The art of casting horoscopes can be said to be a typical Hellenistic product, the result of the close contact between Greek and oriental cultures.[81] We possess Greek papyri from Egypt from the beginning of our era to the Arabian conquest showing us the application of astronomical methods in a great number of specific horoscopes and in minor astronomical treatises.[82] In addition, an enormous astrological literature is preserved, catalogued during the last fifty years in the twelve volumes of the *Catalogus* by Cumont and

[77] The commentaries of Pappus and Theon of Alexandria (and presumably of Hypathia) are of this type. For these texts cf. Rome *CPT*.

[78] Represented, e.g., by Theon of Smyrna (second cent. A.D.) or Proclus (fifth cent. A.D.).

[79] Edited by Nobbe (1843). The first chapter is excellently discussed by Mžik and Hopfner *PDE*.

[80] Edited and translated in the "Loeb Classical Library" by H. L. Jones (8 vols.; 1917–32).

[81] Cf., e.g., Capelle [1], who shows that only weak traces of astrological ideas in Greek literature can be followed as far back as 400 B.C.

[82] Concerning horoscopes, see above, n. 17. Examples of astronomical treatises are Pap. Ryl. 27, 464, 522/24, 527/28, or Curtis-Robbins [1].

his collaborators.[83] Finally, Vettius Valens, who wrote shortly before Ptolemy,[84] and Ptolemy himself as the author of the famous *Tetrabiblos*, must be mentioned.[85]

Modern scholars have not yet made full use of this vast material. The reason is only too clear: the amount of work to be done surpasses by far the power of a single individual, and the work itself is certainly not very pleasant. The astronomical part must be extracted from occasional remarks, short computations, and similar instances submerged beneath purely astrological matter of a very unappealing character. But this work must eventually be done and will give valuable results. As an example might be mentioned the question of discovering the principle according to which the equinox was placed in the zodiac. This question must be answered, for on it depend our calculations in the determination of constellations, chronology, etc. Moreover, systematic checking of astrological computations will frequently yield information about the character of the astronomical tables used at the time.

We touch here upon a point of great importance for the modern attitude toward ancient astronomy. The usual treatment of ancient sciences as a homogeneous type of literature is very misleading. It is necessary to realize that very different levels of astronomy or mathematics were coexistent, almost without mutual contact or interference. One misses the essential points in the understanding of ancient astronomy if one naïvely considers various documents in their chronological order. Even works by the same person must sometimes be separated from one another. Ptolemy's *Almagest* is purely mathematical, the *Tetrabiblos* (written after the *Almagest*)[86] is purely astrological, and his *Harmonics*[87] contains a chapter on the harmony of spheres employing concepts of the planetary movements which contains such strong simplification of the actual facts that one would try in vain to find similar assumptions in any of the other works of Ptolemy. In other words, it is necessary to evaluate each text in its proper surrounding and according to its traditional style. One cannot, for example, speak without qualification of the contact between Babylonian and Greek astronomy. Such a contact might even have worked in opposite directions in different fields. For instance, we have already referred to the possibility that Hellenistic astrology returned to Babylonia in the form acquired in Egypt or Syria, whereas observational material from Mesopotamia undoubtedly influenced Greek mathematical astronomy deeply. In general, it can be said that the growth of ancient sciences shows much more irregularity and stratification than modern scientists, accustomed to the fact of the uniform spread of modern ideas and methods, are prone to assume.

The lack of uniformity in the whole field of ancient astronomy in general necessarily interferes also with the investigation of any special problem. We have already mentioned the fact that astrology in the Assyrian age differed considerably from the horoscopic type which prevailed in late antiquity and the Middle Ages. But there exists a third type, standing between the omina type ("when this and this happens in the skies, then such and such a major event will be the consequence") and the individual birth horoscope, namely, the "general prognostication," explained in full detail in the first two books of the *Tetrabiblos*. This type of

[83] *CCAG*. Cf. also Boll [2].

[84] Kroll *VV*.

[85] Ptolemy, *Opera* III, 1, and "Loeb Classical Library" (ed. F. E. Robbins).

[86] This follows from the introduction to the *Tetrabiblos*.

[87] Düring *HP* and *PPM*.

astrology is actually primitive cosmic physics built on a vast generalization of the evident influence of the position of the sun in the zodiac on the weather on earth. The influence of the moon is considered as of almost equal importance, and from this point of departure an intricate system of characterization of the parts of the zodiac, the nature of the planets, and their mutual relations is developed.[88] This whole astronomical meteorology is, to be sure, based on utterly naïve analogies and generalizations, but it is certainly no more naïve and plays no more with words than the most admired philosophical systems of antiquity. It would be of great interest for the understanding of ancient physics and science in general to know where and when this system was developed. The question arises whether this is a Greek invention, replacing the Babylonian omen literature, which must at any rate have lost most of its interest with the end of independent Mesopotamian rule, whether it precedes the invention of the horoscopic art for individuals or merely represents an attempt to rationalize the latter on more general principles.[89] Thus we see that even in a single field of ancient astronomical thought the most heterogeneous influences are at work; the analysis of these influences has repercussions on almost every aspect of the study of ancient civilizations.[90]

15. The same branching-off into very different lines of thought must also be recognized in the development of Greek mathematics. The line of development characterized by the names of Eudoxus, Euclid, Archimedes, and Apollonius is to be separated sharply from writings like Heron[91] and Diophantus[92] or the *Arithmetic* of Nicomachus of Gerasa.[93] Here, again, the question of oriental influence cannot be discussed as one common phenomenon. Egyptian calculation technique and mensuration were certainly continued in similar works in Hellenistic Egypt and found their way into Roman and medieval practices. At the same time, Babylonian numerical methods influenced Alexandrian astronomy. How Babylonian algebraic concepts eventually reached Greek writers like Diophantus is still completely unknown, but that it did is supported by the strong parallelism in methods and problems.[94] Equally lacking is detailed information as to the revival of these methods in Moslem literature.[95] On the other hand, the problems which emerged from the discovery of the irrational numbers are undoubtedly of Greek origin. It is, however, not correct to consider writings of the same person as equally representative of "Greek" mathematics. Those parts of Euclid's *Elements* (the majority of the work) which deal more or less directly with the problem of irrational numbers are, as we said before, Greek. Most likely of equally Greek origin is Euclid's astronomical treatise called *Phenomena*,[96] which is written on so elementary a level that nobody would attribute it to the author of the *Elements* if the authorship were not so firmly established. And, finally, Euclid's *Data*[97] contains the treatment of purely algebraical problems by geometrical means—which can be interpreted as the direct geometrical transla-

[88] For the whole complex of the ancient justifications of astrology, see Duhem, *SM*, II, 274 ff.

[89] This is the assumption of Kroll [1], p. 216, for the tendency exhibited in Ptolemy's *Tetrabiblos*.

[90] Cf. the excellent survey of this situation in Boll [2].

[91] First century A.D.; cf. for this date Neugebauer [14], pp. 21 ff.

[92] Usually dated about A.D. 300; cf., however, Klein [1], p. 133, n. 23.

[93] Greek text ed. Hoche (Leipzig, 1866); English translation: D'Ooge-Robbins-Karpinski *Nic.*

[94] Vogel [2]; Gandz [3].

[95] Gandz [1], [2], [3].

[96] *Opera* VIII; cf. above, p. 16.

[97] *Opera* VI.

tion of methods well known to Babylonian mathematics.[98] These methods of "geometrical algebra" in turn determine the whole structure of Apollonius' theory of conic sections.[99]

Greek mathematics is by far the best-investigated field of ancient science (and of the history of science in general);[100] the situation with respect to the source material is very good[101]—except where only Arabic manuscripts are preserved.[102] But one must not forget that also this tradition suffers from severe gaps. This is due not only to the destruction of manuscripts over a period of two thousand years but also to the effect of literary influence. I refer not only to the above-mentioned elimination of older treatises by the overshadowing of the great works of the Hellenistic period. The Greeks themselves contributed to the distortion of the picture of the actual development by inventing seemingly plausible stories where the real records were already lost. The oft-repeated stories about Thales, Pythagoras, and other heroes are the result.[103] We should now realize that we know next to nothing about earlier Greek mathematics and astronomy in general and about the contact with the Near East and its influence in particular. The method which involves the use of a few obscure citations[104] from late authors for the restoration of the history of science during the course of centuries seems to me doomed to failure. This amounts to little more than an attempt to understand the history of modern science from a few corrupt quotations from Kant, Goethe, Shakespeare, and Dante.

16. Undoubtedly the most spectacular advances in the history of astronomy until very recent times were scored in the theory of the planets. The catch-words "Ptolemaic" and "Copernican" refer to different assumptions as to the mechanism of the planetary movement. This is not the place to underline the fact that the Copernican theory is by no means so different from or so superior to the Ptolemaic theory as is customarily asserted in anniversary celebrations,[105] but we must briefly analyze Ptolemy's own claims to having been the first one who was able to give a consistent planetary theory.[106] This claim seems to contradict not only the existence of pre-Ptolemaic planetary tables in Roman Egypt as well as in Mesopotamia but also Ptolemy's own reference to such texts. What Ptolemy means, however, becomes clear if one reads the details of the introduction to his own theory. He requires an explanation of the planetary movement by means of a combination of uniform circular movements which refrains from simplifications like the assumption of an invariable amount for the retrograde arc and similar deviations from the actual observations. Indeed, in order to remain in close agreement with the observations, Ptolemy had to overcome difficulties which Hipparchus was not able to

[98] Neugebauer [15].

[99] Zeuthen *KA* and Neugebauer [16].

[100] Best exposition: Heath *GM* and *MGM* and Euclid. A selection of texts is given in Thomas *GMW*.

[101] Most of the texts are edited in the Teubneriana collection.

[102] Menelaos alone is now edited (Krause *Men.*), but Books v, vi, and vii of Apollonius' *Conic Sections* are still unavailable in a modern edition. Archimedes' construction of the heptagon is published in a free translation of the Arabic version in Schoy *TLAB*, pp. 74–91; cf. also Tropfke [1].

[103] As an example might be mentioned the criticism of the story of the Thales eclipse by Pannekoek [3], p. 955; Dreyer *HPS*, p. 12, n. 2; Neugebauer [9], pp. 295–96. Cf. also Frank, Plato, or Heidel [1].

[104] The fragments collected by Diels *VS* not only give an extremely incomplete picture of the lost writings but were certainly very much distorted by the authors from whose works they are taken. One needs only to look at the picture of oriental writings obtained from Greek tradition as compared with the originals.

[105] The correct estimate can be found in Thorndike *HM*, Vol. V, chap. xviii.

[106] *Almagest* IX, 2.

master and which led Ptolemy to a model which is very close to Kepler's final solution of the problem, by assuming not only an eccentric position of the earth but also an eccentric point around which the movement of the planetary eccenter appears to be uniform. The resulting orbit is of almost elliptical shape with these two points as foci.[107] This whole theory is closely related in method to the explanation of the "evection" of the moon (a periodic perturbation of the moon's orbit discovered by Ptolemy) by a combination of eccentric and epicyclic movements. Both theories are real masterpieces of ancient mathematical astronomy which far surpassed all previous results.

It is not surprising that Ptolemy's results overshadowed all previous works. All that we know about his forerunners comes mainly from the *Almagest* itself. We hear that Hipparchus used eccenters and epicycles for the explanation of the anomalies in the movement of the sun and the moon,[108] and we learn about theorems for such movements proved by Apollonius.[109] This brings us to the very period (about 200 B.C.) from which the oldest cuneiform planetary texts are preserved—computed, however, on entirely different principles. These cuneiform texts cover the two centuries down to the time of Caesar. A direct continuation, chronologically speaking, but of still another type, are planetary tables from Egypt, written in Demotic or Greek.[110] These tables give the dates at which the planets enter or leave the signs of the zodiac. Such tables were known to Cicero[111] and are most likely the "eternal tables" quoted with contempt by Ptolemy.[112] We do not know how these tables were computed, and their occurrence in Greek as well as in Demotic leaves us in doubt as to their origin—showing us only the degree of interrelation we can expect in Hellenistic times.

The most interesting question would, of course, be to learn more about Hipparchus' astronomy. He is most famous as the discoverer of the precession of the equinoxes. Though this fact cannot be doubted,[113] underlining its importance lays the wrong emphasis on a phenomenon which gained its importance only from Newton's theory, which showed that precession depends on the shape of the earth and thus opened the way to test the theory of general gravitation by direct measurements on the earth. For ancient astronomy, however, precession played a very small role, requiring nothing more than sufficiently remote and sufficiently reliable records of observations of positions of fixed stars. The change in positions must then eventually become evident; and little difficulty was encountered in incorporating this slow movement into the adopted model of celestial mechanics. What we actually need to appreciate in Hipparchus' contribution must be derived from a careful study of all relevant sections of the *Almagest*, not by the schematic method of obtaining "fragments" from direct quotations but by a comparison of Ptolemy's methods and the older procedures which he frequently mentions. That such an approach can lead to well-defined results has recently been shown in the theory of eclipses.[114]

17. One of the most important prob-

[107] Cf. Schumacher [1] for the Ptolemaic theory of Venus and Mercury. For the Greek planetary theory in general, see Herz *GB* I.

[108] *Almagest* III, 4.

[109] *Almagest* XII, 1 (=Apollonius, ed. Heiberg, II, 137).

[110] Neugebauer [3]. Cf. above, p. 5.

[111] Cicero *De divinatione* ii. 6, 17; cf. also ii. 71. 146.

[112] *Almagest* IX, 2.

[113] Schnabel's attempts (Schnabel [1]) to prove that precession was taken into consideration in the cuneiform texts are, to say the least, inconclusive and in part based on mere scribal errors.

[114] Schmidt [1].

lems in connection with Hipparchus is, of course, the problem of the dependence of Hipparchus (and Greek astronomy in general) on Babylonian results and methods. Whatever the conclusions derived from a deeper knowledge of Hipparchus' astronomy may turn out to be, one thing is clear: the century between Alexander's conquest of the Near East and Hipparchus' time is the critical period for the origin of Babylonian mathematical astronomy as well as for its contact with Greek astronomy. Since Kugler's discoveries, which showed the exact coincidence between numerical relations in cuneiform tablets and in Hipparchus' theory,[115] no one has doubted Babylonian priority. It is an undeniable fact that the Babylonian theory is based on mathematical methods known already in Old Babylonian times and does not show any trace of methods considered to be characteristically Greek. The problem remains, however, to answer the question: What caused the sudden outburst of scientific astronomy in Mesopotamia after many centuries of a tradition of another sort? On what background can we understand, for example, the report[116] that the "Chaldaean" Seleucus from Seleucia on the Tigris[117] completed the heliocentric theory, previously proposed as a hypothesis by Hipparchus? Greek influence on late Babylonian astronomy must not be denied or asserted on aprioristic grounds, if we really want to understand a phenomenon of great historical significance.

These remarks are not intended to make Greek influence alone responsible for the new developments in Mesopotamia. As a matter of fact, this answer would only raise the equally unsolved question why Greek astronomy suddenly emerged from many centuries of primitiveness to a scientific system. The alternative, Greek or Babylonian, might even exclude the right answer from the very beginning. It also seems possible that the rise of mathematical astronomy in Hellenistic times resulted from the suddenly intensified contact between several types of civilization, in some respects to be paralleled with the origin of modern science in the Renaissance. In other words, neither the Greeks nor the Orientals might have been alone responsible for the new development but rather the enormous widening of the horizon of all members of the culture of the Hellenistic age. One result of this process was probably the new attitude toward the relationship between the individual and the cosmos, expressed in the new form of horoscopic astrology. In this case it is quite evident that Egypt and Greece—and perhaps Syria as well—contributed about equally much to the refinement and spread of this new creed. It is equally possible that the contact between Greek scholars, trained to think in geometrical terms which Greek mathematics had developed in the fifth century, and Babylonian astronomers, equipped with superior numerical methods and observational records, brought into simultaneous existence two closely related types of mathematical astronomy: the treatment by arithmetical means in Babylonia and the model based on circular movements in the Greek centers of learning in the eastern Mediterranean. It may well be that competition, not borrowing, was the chief contributor to the initial impetus.[118] At any rate, it is clear that each detail in the development of Hellenistic astronomy which we will be able to understand better will reveal a new aspect in the fascinating process of the

[115] Kugler *BMR*, p. 40.

[116] Plutarch *Plat. quaest.* viii. 1. 1006 C (ed. Bernardakis, *Moralia*, VI, 138). Cf. also Heath, *AS*, pp. 305 ff. and Duhem *SM*, I, 423 ff.

[117] Strabo xvi. 739. Seleucus may have lived about 150 B.C.

[118] Neugebauer [17], pp. 30–31.

creation of the new world which was destined to become the foundation of the Roman and medieval civilizations.

The unique role of the Hellenistic period in the field of sciences, as in other fields, can be described as the destruction of a cultural tradition which dominated the Near East and the Mediterranean countries for many centuries, but also the founding of a new tradition which held following generations in its spell. The history of astronomy in the Hellenistic age is especially well suited to demonstrate that the great energies liberated by the disintegration of an old cultural tradition are very soon transformed into stabilizing forces of a new tradition, which includes about as many elements of development as of stagnation.

V. SPECIAL PROBLEMS

18. Every research program in a complex field will face the need of constant modification and adjustment to unforeseen complications and new ramifications. Problems can arise and results be obtained without having been anticipated in the original question. The context of a mathematical text, for example, can determine with absolute certainty the meaning of a word otherwise only vaguely defined; sign-forms in a papyrus which is exactly dated by astronomical means may furnish valuable information for purely paleographical problems. From dates and positions given in Demotic astronomical texts, it follows that the Alexandrian calendar introduced by Augustus was used by Egyptian scribes only a few years after the reform,[119] very much in contrast to the common opinion that the Egyptians were especially conservative in general and in calendaric matters in particular. In short, from few, but solidly established, facts we can learn more than from all general speculations.

One of the problems which at first sight lies very much outside the history of ancient astronomy is the study of social and economic conditions of the ancient civilizations. There are, however, several points of contact between these studies and astronomy. We are indebted to Cumont for a masterly investigation of the information contained in the astrological literature from Hellenistic Egypt.[120] His results are not only of interest for the history of ancient civilization but also illustrate very well the background of the men who used and transmitted the astronomical material known to us from the planetary tables or from Vettius Valens. It turns out that the soil in which these practices were rooted was essentially Egyptian, in spite of the use of the Greek language in the documents. This is in perfect harmony with the close parallelism between Greek and Demotic planetary texts mentioned above and shows the constant interaction of Greek and native influences in Hellenistic Egypt. It also shows how dangerous it is to decide the authorship of Hellenistic doctrines or methods simply on the basis of such superficial grounds as the language used.

The analogous question for Babylonia seems to be easier to answer. The Mesopotamian origin of the astrological omina cannot be doubted. We would, however, like to know more about the background of the astronomers of the latest period. It is well known that the names of three Babylonian astronomers appear in Greek literature[121] and that two of them actually were found on astronomical tablets, though in an unclear context. For one particular place, the famous city of Uruk in South Babylonia, we can go much further. It can be shown that the scribes and owners of our texts belong to one of two

[119] Neugebauer [6], p. 119.

[120] Cumont *EA*. See also Kroll [1].

[121] Cumont [1].

"families," or perhaps "guilds," of scribes who frequently call themselves scribes of the omen-series "Enuma Anu Enlil."[122] We can follow the work of these scribes very closely for almost a hundred years until the school of Uruk ceased to exist, probably because of the Parthian invasion of Babylonia in 141 B.C. In contrast thereto, the school of Babylon survived the collapse of the Greek regime, as is proved by a continuous series of astronomical texts down to 30 B.C. This is an interesting result in comparison with the assumption that Babylon practically ceased to exist after the Parthian occupation. The grouping of our texts according to well-defined schools is also of interest from another point of view. It can be shown that two different systems of computation existed side by side for a long time. Competing schools of this sort constitute a phenomenon which is usually considered characteristic for Greek culture.

19. Countless thousands of business documents are preserved from all periods of Mesopotamian history. For the urgently needed investigation of ancient economics, a precise knowledge of the metrological systems is of the greatest importance. Unfortunately, the scientific study of Babylonian measures has been sadly neglected. Fantastic ideas about the level and importance of astronomy in the earliest periods of Babylonian history led to theories which brought measures of time and space in close relationship with alleged astronomical discoveries. We know today that all these assumptions of the early days of Assyriology must be abandoned and that Babylonian metrology must be studied from economic and related texts clearly separated according to period and region. For the determination of Old Babylonian relations between various measures, the mathematical texts are of great value because they contain numerous examples which give detailed solutions of problems in which metrological relations play a major role. The consequences of such relations, established with absolute certainty, are manifold. For example, we now know from Old Babylonian mathematical texts the measurements of several types of bricks[123] as well as the peculiar notation used in counting bricks. It is evident that such information is of importance for the understanding of contemporary economic texts dealing with the delivery of bricks for buildings, thus leading to purely archeological questions. Metrological relations are also needed if we wish to gain an insight into wages and prices.[124] Returning to our subject, it must be said that metrology is of great importance not only for the history of the economics of Mesopotamia but also for purely astronomical problems. Distances on the celestial sphere are measured in astronomical texts by units borrowed from terrestrial metrology. The comparison between ancient observation and modern computations thus requires a knowledge of the ancient relations between the various units. This problem is by no means simple because our astronomical material belongs to relatively late periods, Assyrian and Neo-Babylonian, and the metrological system of these times is much more involved than the Old Babylonian. Mathematical texts would certainly be of great help here too, but the few tablets from this period are so badly preserved that they present us with at least as many new questions as they answer. Neo-Babylonian economic texts will therefore furnish the main point of departure for the study

[122] For this series cf. Boll-Bezold-Gundel *SS*, pp. 2 ff., and Weidner [2].

[123] Neugebauer-Sachs *MCT*, Problem-Text O and Sachs [1].

[124] Waschow [1], p. 277, found, in discussing mathematical texts, that the value of the area-measure "še" must be changed by a factor 60 against older assumptions. It is obvious how such facts influence the interpretation of economic texts.

of the latest phase of Mesopotamian metrology and its astronomical applications.

It might be mentioned, in this connection, that theories about direct relationship between early Mesopotamian metrology and astronomy also gave rise to the rather unfortunate concept of high accuracy in the determination of weights, measures of length, etc. It is of great importance to realize that the absolute values of all metrological units are subject to great margins of inaccuracy and local and temporal variations. The first step in a historical investigation of Mesopotamian metrology must therefore be to establish from economic and mathematical texts the *ratios* between the units; these ratios have an incomparably better chance of showing unformity than the absolute values deduced from accidental archeological finds.

20. Closely related to metrological problems is the question of the accurate identification of ancient star configurations. Much work remains to be done before it will be possible to give a reliable history of the topography of the celestial sphere in general, or even of the zodiacal constellations.[125] In spite of attempts to make Egypt responsible for many forms,[126] the predominant influence of Babylonian concepts on the grouping of stars into pictures must be maintained. But neither Babylonian nor Egyptian developments are known in detail. The identification of Egyptian constellations is especially difficult, mainly because it must be based on relations between the times of rising and setting and therefore depends on elements which are grossly schematized in the texts at our disposal. The situation in Mesopotamia is slightly better because we have actual observations in addition to the schematic lists, at least for the later periods which are of special importance for the Hellenistic forms of the constellations.

For the period following the publication of the *Almagest*, we must take into account the possibility of still other complications. We know from explicit remarks in the *Almagest* that Ptolemy's star catalogue introduced deviations from older catalogues.[127] Astrological works, however, may very well have maintained pre-Ptolemy standards both with respect to the boundaries of constellation and the counting of angles in the zodiac. We have already mentioned the stubborn adherence of astrological writers to methods of computation which were made obsolete by the development of spherical trigonometry.[128] For the modern historian it is therefore of importance to establish the specific standard according to which a given document was written, especially when chronological problems are involved.

21. While metrology is a much-needed implement for economic history and the understanding of ancient astronomy, astronomy itself serves general history in chronological problems. Chronology is the necessary skeleton of history and owes its most important fixed points to astronomical facts. We need not emphasize the use of reports of eclipses, especially solar eclipses, for the determination of accurate dates to form the framework into which the results of relative chronology must be fitted. It must be underlined, however, that the available material is by no means exhausted. A better understanding and reinvestigation of the reports of the Assyrian astronomers will certainly furnish new information of chronological value. It must be stated, on the other

[125] The best summary is given by the Boll-Gundel article, "Sternbilder," in Roscher *GRM*, Vol. VI (1937), cols. 867–1072.

[126] Cf. esp. Gundel *DD* and *HT* and the criticism of Schott [2].

[127] *Almagest* VII, 4 (ed. Heiberg, p. 37).

[128] Cf., e.g., *Tetrabiblos* I, 20 (ed. Robbins, pp. 94–95).

hand, that not too much is to be expected from older material. In order to make ancient observations accessible to modern computation, a certain degree of accuracy must be granted; this accuracy seems to be missing in the earlier phases of the development of astronomy. This, for instance, makes the older Egyptian material so ill suited for chronological purposes. For later periods, however, Egypt has furnished and will furnish much information from astrological documents. It is particularly calendaric questions, such as the use of eras and similar problems, which have been illuminated by the dating of horoscopes.

The great variety of calendaric systems, local eras, and older methods of dating raises many difficulties in ancient chronology. This difficulty was clearly felt also by ancient astronomers and was the cause of the early use of consistent eras in Babylonian and Greek astronomy. The Babylonian texts always use the Seleucid Era, whereas Ptolemy reduces all dates to the Nabonassar Era but uses the Old Egyptian years of constant length. This crossing of Egyptian and Babylonian influences is paralleled by the subdivision of the day into hours. The Egyptians divided the day into twelve parts from sunrise to sunset, thus obtaining hours whose length depended on the season. The Babylonian astronomers used six subdivisions of day and night, but these units were of constant length. Combining the Egyptian division into 24 hours with the Babylonian constancy of length, the Hellenistic astronomers used "equinoctial" hours for their computations and solved the problem of finding the relationship between seasonal and equinoctial hours by spherical trigonometry.[129] One sees here again what a multitude of relations, problems, and methods contributed to shape concepts such as a continuous era or the 24-hour day which are so familiar to us today.

Ancient chronology and the accurate analysis of ancient reports have turned out to be of interest even to a modern astronomical problem. In 1693 Halley discovered the fact[130] that the moon's position appeared to be advanced compared with the expected position as computed from positions recorded by Ptolemy. This "acceleration" can be explained by a slow increase in the length of the solar day or by a decrease in the rotational velocity of the earth. Such a decrease is caused by tidal forces,[131] and it is of great interest to determine the amount as accurately as possible. For this purpose, accurate positions of the moon in remote times are of great value, and such positions can, indeed, be derived from records in cuneiform texts.[132] Modern measurements of high precision can thus be supplemented by observations in antiquity.

22. Not only are Hellenistic astronomy and Hellenistic astrology the determining factors for the astronomy and astrology of the Middle Ages in Europe, but its influence is equally important for the development of astronomical methods and concepts in the Middle and Far East. We must therefore at least mention an enormous field which still awaits systematic research: Hindu science. This does not mean that there is not an extensive literature on this subject; indeed, even a small number of original texts are published.[133] The main trouble lies, however, in the tendency of the majority of publications by Hindu authors to claim priority for Hindu discoveries and to deny foreign in-

[129] *Almagest* II. 9.

[130] Edm. Halley, "Emendationes ac notae Abatênii observationes astronomicas, cum restitutione tabularum lunisolarum ejusdem authoris," *Philosophical Transactions*, **17** (1693), No. 204, pp. 913–21.

[131] Cf., e.g., Jeffreys [1].

[132] P. V. Neugebauer [1].

[133] For the literature until 1899, see Thibaut *A A M*. The best discussion of Hindu astronomy is still Burgess *SS* (1860).

fluence, as well as in the opposite tendency of some European scholars. This tendency has been especially strong so far as Hindu mathematics is concerned,[134] and it is aggravated by the inadequate publication of the original documents, from which usually only scattered fragments are cited in order to prove some specific statement. As a result, there is no means today to obtain an independent judgment from the study of the original texts which are preserved in enormous number, though of relatively late date for the most part.

The situation with respect to Hindu astronomy is not much better. There can be little doubt that the original impetus came from Hellenistic astronomy; the use of the eccentric-epicyclic model alone would be sufficient proof even if we did not also find direct witness in the use of Greek terminology.[135] This fact is interesting in itself, but it may very well be that the period of reception lies between Hipparchus and Ptolemy; systematic study might therefore reveal information about pre-Ptolemaic Greek astronomy no longer preserved in available Greek sources. Hindu astronomy would in this case constitute one of the most important missing links between late Babylonian astronomy and the fully developed stage of Greek astronomy represented by the *Almagest*.

The fundamental difficulty in the study of Hindu astronomy lies in the character of the preserved textual material. The published and commented texts consist exclusively of cryptically formulated verses giving the rules for computing certain phenomena, making it extremely difficult to understand the actual process to be followed. It is evident, on the other hand, that no astronomy of an advanced level can exist without actually computed ephemerids. It must therefore be the first task of the historian of Hindu astronomy to look for texts which contain actual computations. Such texts are, indeed, preserved in great number, though actually written in very late periods. Poleman's catalogue[136] of Sanskrit manuscripts in American collections lists about a hundred such manuscripts in the D. E. Smith collection in Columbia University in New York. In their general arrangement, these texts are reminiscent of the cuneiform ephemerids from Seleucid times and must reveal many details of the Hindu theory of the planetary movement if attacked by the same methods which have proved so successful in the case of the Babylonian material. The complete publication of this material is an urgent desideratum in the exploration of oriental astronomy.

As mentioned above, the texts in the D. E. Smith collection are of very recent origin, only a few centuries old. This does not mean that the methods used are not of very much earlier date. This is shown by the investigation of one of these texts,[137] which deals with the problem of the varying length of the days during the year. Though written about 1500, the computations are based on methods going back to a much older period. Analogous results can be expected in the remaining material, and there is no reason to assume that the D. E. Smith collection exhausts all the preserved material.

23. In the preceding sections we have frequently touched on methodological questions. In closing, I wish to underline a few principles in a more general way. As is only natural, the study of the development of ancient science began under the

[134] Cf., e.g., Datta-Singh *HHM* (reviewed in Neugebauer [12]).

[135] Thibaut *AAM*, pp. 43 ff. The Babylonian ratio 3 : 2 for the ratio between the longest and shortest days of the year also occurs in India (Thibaut *AAM*, pp. 26–27; Kugler *BMR*, pp. 82 and 195), though it would be suitable only for the latitude of the northern corner of India. For the planetary theory, see Kugler *BB*, p. 120; Schnabel [2], p. 112; Schnabel [1], p. 60.

[136] Poleman *CIM*, pp. 231 ff. See also Emeneau *PIT*, pp. 318 ff.

[137] Schmidt [2].

influence of the ancient tradition. Herodotus, Diodorus, the commentators of Plato, etc., were the sources which determined the picture of the early stages of Greek and oriental mathematics and astronomy. But while students of political history, art, economics, and law learned in the early days of systematic archeological research to consider this literary tradition about the ancient Orient as nothing more than a supplementary source to be checked by the original documents, the majority of historians of the exact sciences have remained in a stage of naïve innocence, repeating without criticism the nursery stories of ancient popular writers. This is all the more surprising because many of these stories should have revealed their purely fictitious character from the very beginning. Every invention considered of basic importance is attributed to a definite person or nation: Thales "discovered" that a diameter divides the area of a circle into two equal parts, Anaximandes and several others are credited with the discovery of the obliquity of the ecliptic, the Egyptians discovered geometry, the Phoenicians arithmetic—and so on, according to an obvious pattern of naïve restoration of facts the origins of which had been totally forgotten. Modern authors then add stories of their own, such as the idea that the construction of the pyramids required mathematics, the assumption of supposedly marvelous skies of Mesopotamia,[138] and the notion of Egyptian Stone Age astronomers industriously determining the heliacal rising of Sirius or carrying out a geodetic survey of the Nile Valley.

It is clear that the replacement of the traditional stories by statements based exclusively on results obtainable from the original sources will not be very appealing. This is the inevitable result in the development of every science; for increased knowledge means giving up simple pictures. In the history of science, an additional element must be added to the steady increase of complexity resulting from a better understanding of our sources. Not only do we learn to interpret our material more accurately but we also learn to see everywhere the immense gaps in our preserved sources. We will more and more be forced to admit that many, and essential, steps in the development of science are hopelessly destroyed; that we, at best, are able to sketch mere outlines of the history of science during certain sharply limited periods; and that many of the driving forces might actually have been quite different from those which we customarily restore on the analogy of later periods.

One consequence of this situation seems to me to be evident: unless the history of science now enters the stage of specialization, it will lose all value in the framework of historical research. It must be clearly understood that the history of science must work with methods and must consider its problems from viewpoints which correspond to the methods and standards of other branches of historical research. The idea must definitely be abandoned that the history of science must adapt its level to the alleged requirements of the teaching of the modern fields of science. The intrinsic value of this research must be seen in its contribution to our understanding of the historical processes which shaped human civilization, and it must be made clear that such an understanding cannot be reached without the closest contact with the other historical fields. The call for specialization is not very popular. I am convinced, however, that a well-founded insight into the details of a single essential step in the development is at present of higher value and more fascinating than any attempt at general syn-

[138] For the poor conditions of actual observation cf. Koldewey *WB*, p. 192; Vogt [1], pp. 38–39; cf. also Boll [1], pp. 48 and 157.

thesis. It is ridiculous to believe that we are anywhere able to reach "final" results in the study of the development of human civilization. But the overwhelming richness of all phases of human history can be appreciated only if we occupy ourselves with the real facts as accurately as possible and do not attempt to hide their manifold aspects under the veil of hazy generalizations or let our judgment be guided by the naïve idea of human "progress." Every synthesis written fifty years ago is now completely antiquated and at best enjoyable for its literary style; the careful study of the original works of the ancients, however, will reveal to everyone and at any time the development of their achievements.[139]

The call for specialization must not be misunderstood as a plea for the disregard of the general outlines of the historical conditions. On the contrary, specialized work can be accomplished successfully only if the points of attack are selected under constant consideration of possible interference from other problems and other fields. It is indeed the most gratifying result of detailed research on a well-defined problem that it necessarily uncovers relationships which are of primary importance for the understanding of larger historical processes. The actual working program, however, needs restriction and minute detail work. The most essential task is that of making the original sources accessible as easily as possible in their best available form. By the indefatigable work of Heiberg, Hultsch, Tannery, and many others, we possess today a great part of the extant writings of the Greek scientists in excellent editions. We owe to Sir Thomas Little Heath many brilliant commentaries and translations of Greek mathematicians.[140] To make Greek and oriental source material more generally accessible, supplemented, of course, by modern translations and commentaries, will be the foremost problem of the future. The extension of this program to include medieval material, on the one hand, and Middle Eastern documents on the other, appears as a logical consequence, worthy of the serious efforts of all scholars who wish to contribute to the understanding of the past of our own culture.

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[139] An excellent example is Delambre *HAA*, published in 1817 and still not surpassed or even equaled because of its direct contact with the original sources.

[140] On the other hand, much remains to be done to repair the harm caused by classical philologists who made their editions inaccessible to modern scientists by translating them into Latin instead of a modern language. Great opportunities have been spoiled by this absurd attitude. It has fortunately never occurred to Orientalists to translate their texts into Hebrew. It should be mentioned, however, that the Arabic version of Euclid's *Elements* was published in Latin(!) translation by Besthorn, Heiberg, and others (Copenhagen, 1897–1932).

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AJSL	*American Journal of Semitic Languages and Literatures.*
Almagest	*See* Ptolemy.
AN	*Astronomische Nachrichten.*
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OLD PERSIAN TEXTS

ROLAND G. KENT

VI. DARIUS' NAQŠ-I-RUSTAM B INSCRIPTION

THE trilingual inscriptions on the tomb of Darius the Great at Naqš-i-Rustam are among the most interesting of the ancient Persian records, containing not merely Darius' own statement of his achievements, but also his evaluation of his own character: however prejudiced his account, it is a Persian's account of what a Persian ought to be. Now these inscriptions, apart from the smaller legends attached to individual figures in the sculptures, consist of two sets of panels: the upper, known as Darius NRa, or more briefly DNa (which is my preference), with Darius' account of his achievements; and the lower, known as Darius NRb or DNb, with his account of his character.

DNa is more easily legible, and the complete text of the three versions has long been known in virtually correct form, though a few revisions have been made in recent years as a result of renewed scrutiny and new photographs. But DNb, which is more poorly preserved, has been known only in very defective form until a few years ago, when Ernst Herzfeld made a painstaking examination, the results of which he published in 1938 in his *Altpersische Inschriften*, pages 4–13, with charts of the OP and Akkadian versions in the original cuneiform script, showing the characters and parts of characters which were visible to him. He presented also the OP and Akkadian texts in transliteration and in normalized form, with a translation into German, and some brief notes on these texts and on the fragments of a fourth version in Aramaic; this stands at the foot of a panel below the third or Elamite version, which is the most damaged and is still unread. Herzfeld's Plate III gives a portion of the OP text, from an excellent photograph.

After the receipt of Herzfeld's volume, I attempted a complete presentation of the OP version in *Language*, XV (1939), 160–75, following Herzfeld in most matters connected with DNb, but seeking to fill as many as possible of the remaining gaps. This text can now be somewhat modified and improved with the aid of photographs taken for Erich F. Schmidt in 1938, which have courteously been placed at my disposal by the authorities of the Oriental Institute of the University of Chicago. Professor George G. Cameron has also allowed me to use his own unpublished transcript of the first 41 lines of the OP text (of DNb), made from the Schmidt photos without reference to other sources and thus avoiding possible erroneous presuppositions, with his subsequent critical notes; he has also meticulously compared my text and notes with enlargements of the Schmidt photographs, and allowed me to incorporate the results of this comparison. His more than friendly help has been so thoroughgoing that in fairness I must insist that any merits which this article may have are attributable quite as much to him as to me.

The Schmidt photographs were taken in a horizontal position from a gigantic scaffolding erected in front of the inscription, and show the entire OP text of DNb (corresponding photos of the other versions were made, but their interpretation

lies outside my competence).[1] In quality they are much superior to the older photographs (listed in *Lang.*, XV, 161), as is shown by the readings which they yield; quantitatively, they show the entire text, while Herzfeld's Plate III in *ApI* gives only the first half of lines 1–19. On the other hand, they do not entirely replace Herzfeld's hand-drawn chart and his transcription, since the visibility of cuneiform characters in a photograph depends upon the casting of shadows and the differing intensities of the illumination on directly illuminated surfaces; thus where the surface has scaled or otherwise weathered there may still be traces of the strokes which can be identified by the human eye, but would fail to give an identifiable record upon a photograph which portrays its subject from a single position and with a single direction of the illumination. Where, then, the photographs give positive evidence, they must be preferred to Herzfeld's chart and transcription; but where the photographs fail to show as legible characters or strokes which Herzfeld records as visible to his ocular scrutiny, the preference must be given to Herzfeld's testimony.

The OP text of DNb now follows, as revised in accordance with the added help of the Schmidt photographs. The symbols °, °°, °°°, are used to indicate gaps on the rock surface adequate for one, two, three characters, respectively, where unusual roughness or crevices made the engraving of characters unduly difficult or even impossible; but the spacing of characters is often irregular, and in some instances a place marked by ° in our text may be only a wider separation, not an intentional gap.

TEXT

1 baga : vazraka : Auramazdā : hya : adadā : i-
2 ma : frašam : tya : vainatai[y] : hya : adadā : ši-
3 yātim : martiyahyā : hya : xraθum : ut-
4 ā : aruvastam : upariy : Dārayavaum : xšā-
5 yaθiyam : nīyasaya : θātiy : Dārayavauš : xšāya-
6 °θiya : vašnā : Auramazdāhā : avākaram : a-
7 miy : tya : rāstam : dau[št]ā : amiy : miθa : na-
8 [i]y : dauštā : amiy : na[imā] : kāma : tya : skauθ-
9 iš : tunuvatahyā : rā°diy : miθa : kariyaiš
10 : naimā : ava : kāma : tya : t[u]nuvā : skauθaiš : r-
11 ādiy : miθa : kariyaiš : tya : rāstam : ava : mām :
12 kāma : martiyam : draujanam : naiy : daušt[ā] : am-
13 iy : naiy : manauviš : am[iy : ty]āmaiy : [da]rtana-
14 yā : bavatiy : daršam : dārayāmiy : manahā :
15 uvaipašiyahyā : darša[m :] xšayamna : a[m]iy [:]
16 martiya : hya : hataxšataiy [:] anudim [: ha]karta°-
17 hyā : avaθādim : paribarāmiy : hya : [v]°-
18 ināθayatiy : anudim : vinastah[yā : ava]θ-
19 ā : parsāmiy : naimā : kāma : tya : mar°tiya
20 : vināθayaiš : naipatimā : ava : kāma : yadi-
21 y : vināθayaiš : naiy : fraθiyaiš : martiya :

[1] [Photographs of all Naqš-i-Rustam inscriptions will be published by the Oriental Institute in Schmidt's final report on the Persepolis Expedition, now in preparation.—G.G.C.]

22 tya : pat°iy : martiyam : θātiy : ava : mām :
23 naiy : varnavataiy : yātā : uradanām : hadu-
24 gām : āxšnautiy : martiya : tya : kunau-
25 tiy : yad°ivā : ābaratiy : anuv : tauman-
26 išaiy : xšnuta : °° amiy : utā : mām : vas-
27 iy : kāma : utā : u[xšna]uš : amiy : avākaram-
28 camaiy : ° ušīy : u[t]ā : framānā : yaθāmai-
29 y : tya : kartam : vaināhy : [ya]divā : āxšnav-
30 āhy : utā : viθ°i°yā : °° utā : spāθma-
31 i°da°yā : aitamai°y° : °°° aruvastam :
32 upariy : manašc[ā] : °° [uš]īcā : ima : patimai-
33 y : aruvastam : t°ya°maiy : tanūš : tāvaya-
34 t[i]°y : hamaranakara : a[m]°iy : ušhamaranakara : hakara-
35 mci°y : ušīyā : gā[θa]°vā : vainātaiy : yaciy :
36 va[i]nāmiy : hamiçiya°m : yaciy : naiy : vainā-
37 miy : utā : ušībiyā : utā : framānāyā
38 : a°dakaiy : fratara : maniyaiy : aruvāyā : ya-
39 di°y : vaināmiy : hamiçiyam : yaθā : yadiy :
40 nai°y : vaināmiy : yāumainiš : amiy : u-
41 tā ° : dastaibiyā : utā : pādaibiyā : asabā-
42 ra [:] ° uvāsabāra : amiy : θanuvaniya : uθa-
43 n°uvaniya : amiy : utā : pastiš : utā
44 : asabāra : āršt[i]ka : amiy : uvārštika :
45 utā : pastiš : utā : asabāra : utā : ūvnarā
46 : tyā : Auramazdā : [upa]r[iy : mā]m : nīyasaya : utā-
47 diš : atāvayam : barta[nai]y : vašnā : Auramazdāh-
48 ā : tyamaiy : kartam : imaibiš : ūvnaraibiš : aku-
49 navam : tyā : mām : Auramazdā : upariy : nīyasaya

50 : marī°kā : daršam : azdā : kušuvā : [ciy]ākaram
51 : am[i]y : ciyākaramcamaiy : ūv[narā : c]iyākara-
52 mcamaiy : pariyanam : mātaiy : ++++++tam :
53 θadaya ° : tyataiy : gaušāyā : [xšnutam] : avaš-
54 ciy : ° āxšnudiy : tya : parta[mtaiy : as]ti-
55 y : marī°kā : mātaiy : avaš[ciy :] ++++++?ta-
56 [m] : kuna°vātaiy : tya : [manā : kartam : as]tiy
57 : avašciy : dīdiy : yaciy [: nipištam] : mā :
58 [ta]iy : [d]ātā : +++++ : mā [:] ++++++ātiy-
59 ā : ayāu(ma)iniš : bavātiy [: marīkā : xšāya]θiya
60 : mā : raxθatuv : ++++++++++++++ina :

TRANSLATION

1–5: A great god is Ahuramazda, who created this excellent work which is seen, who created happiness for man, who bestowed wisdom and activity upon Darius the king.

5–11: Says Darius the king: By the favor of Ahuramazda I am of such a sort that I am a friend to right, I am not a friend to wrong; it is not my desire that the weak man should have wrong done to him by the mighty; nor is that my desire,

that the mighty man should have wrong done to him by the weak.

11–15: What is right, that is my desire. I am not a friend to the man who is a Lie-follower. I am not hot-tempered. What things develop in my anger, I hold firmly under control by my will-power. I am firmly ruling over my own (impulses).

16–21: The man who co-operates, him according to his co-operative action, thus him do I reward. Who does harm, him according to the damage thus I punish. It is not my desire that a man should do harm; nor indeed is that my desire, if he should do harm, he should not be punished.

21–24: What a man says against a man, that does not convince me, until he satisfies the Ordinance of Good Regulations.

24–27: What a man does or performs (for others) according to his (natural) powers, (therewith) I am satisfied, and my pleasure is abundant, and I am well satisfied.

27–32: Of such a sort is my understanding and my command: when what has been done by me thou shalt see or hear of, both in the city and in the war-camp, this is my activity over my will-power and my understanding.

32–40: This indeed is my activity: as far as my body has the strength, as a battle-fighter I am a good battle-fighter. Once let there be seen with understanding in the place (of battle), what I see (to be) rebellious, what I see (to be) not (rebellious), both with understanding and with command then I am first to think with action, when I see a rebel as well as when I see a not-(rebel).

40–45: Trained am I both with hands and with feet. As a horseman I am a good horseman. As a bowman I am a good bowman both afoot and on horseback. As a spearman I am a good spearman both afoot and on horseback.

45–49: And the (physical) skillfulnesses which Ahuramazda has bestowed upon me and I have had the strength to use them—by the favor of Ahuramazda, what has been done by me I have done with those skillfulnesses which Ahuramazda has bestowed upon me.

[The space of one line is here left vacant, to mark the break in the subject matter.]

50–55: O menial, vigorously make thou known of what sort I am, and of what sort my skillfulnesses, and of what sort my superiority. Let that not seem [trifling] to thee, which has been heard by thy ears. That do thou hear, which is communicated to thee.

55–60: O menial, let not that be made [trifling] to thee, which has been done by me. That do thou behold, which [has been inscribed]. Let not the laws [be disobeyed] by thee. Let not [anyone] be untrained [in obedience]. [O menial], let not the king (feel himself obliged to) inflict punishment (?) [for wrongdoing (?) on the dwellers (in the land) (?)].

NOTES

Examination of the Schmidt photographs gives occasion for the following notes on the text, as compared with my previous version; some exegetical notes also are included at the proper places.

3: Only slight traces are visible of the first character of *xraθum*, but those are not incompatible with x^a.

4: On etymology and meaning of *aruvastam*, see Excursus III.

9: The photo seems to show *rā°diy*, the gap being at a fissure in the rock, and the next two signs being only faintly visible.

13–15: For text and interpretation, see Excursus I.

16 end: The photo seems to show $+k^a r^a r^a +$; but the second r^a may really be the beginning of a t^a (as Cameron points out), for the middle of the three short horizontals of r^a may be illusory.

The most probable reading is therefore *[ha]karta-*, with a blank space at the end of the line, where there is a deep hole in the rock.

17 end: After the lost v^i there was a blank unengraved space, in the same area of damage to the surface seen at the end of line 16.

19: The *a* of *naimā* is clear in the photo; Herzfeld had it in his transliteration, but not on his chart.

19 end: The final word is *mar°tiya*, with very slight traces of t^a and *i*. As Cameron notes, Herzfeld's m^a at the end of the line is an error; the y^a at the end is clearly visible in the photo. The word is therefore not object, but subject of the verb in 20, which changes the translation but not the meaning of the sentence.

22: All the characters of *martiyam* are at least partly visible.

23: In *varnavataiy* the v^a and r^a are rather widely spaced, but are not quite far enough apart to justify the marking of a blank space.

24: In *martiya* the m^a seems to be miswritten t^a by the addition of a second short horizontal before the verticals.

25: As Cameron notes, there is a blank space in *ycd°ivā*.

26: The divider immediately follows *xšnuta*, but between the divider and *amiy* there is space for two characters. Cameron sees here some traces of two unsuccessful attempts to inscribe the *a* of *amiy;* but these seeming marks may be only the roughness of a surface which defied utilization.

28: The photo shows $°\,u\check{s}^a iy^a$, though the traces of *u* and $\check{s}^a$ are hard to see. For length of *ī* in normalized *ušīy*, cf. *Lang.*, XIX, 224–25.

28: As Cameron notes, the gap in *u[t]ā* is abnormally great for the single character; but the characters of this inscription are often widely spaced, and if the t^a stands in the middle of the gap there would not be blank space for another character on either side.

30: Read *viθ°i°yā : °° utā*, with double blank before *utā*, as noted by Cameron.

31: This line seems to have *aitamai°y ° : °°° aruvastam :*, without Herzfeld's restored *dīdiy* 'see!' in the gap, despite Akk. *a-mu-ur* at the corresponding place. The gap in the OP could hold *dīdiy* only with extreme crowding (so both Cameron and I, from the Schmidt photo), and the characters in this line are elsewhere loosely spaced. Further, a very distinct divider stands almost in the middle of the gap; and this part of the line stands between unengraved portions of the preceding and the following lines, the area of bad surface apparently extending over all three lines.

32: In *upariy* the traces of r^a are very slight, but are adequate.

32: In *[uš]īcā* the *i* is clearly visible (so Schmidt photo as well as Herzfeld; my failure to indicate this in my previous article is an error). The rock is smooth and unmarked where the *uš* would have stood; whether the two characters were omitted in the engraving (as seems likely to Cameron), or have entirely weathered off, cannot be decided.

33–40: On the interpretation of these lines, in comparison with the Akkadian text, see Excursus II.

35: There is a blank space in *gā[θa]°vā;* the θ^a is entirely lost. Of the v^a I seem to see faint traces, but Cameron regards the character as entirely lost.

35: For *vainātaiy*, Cameron finds that the photo shows rather $h^a in^a t^a t^a iy^a$, which, if a correct reading, is an incorrect engraving. The Schmidt photo does in fact seem to favor h^a for the first character; but Herzfeld's chart indicates that he saw v^a quite distinctly, and the traces in the photo are of the vague illusory kind. The fourth character, however, is in the photo

quite distinctly t^a (hardly m^a), and we must assume that the engraver inscribed t^a-t^a for a-t^a, an easy error of substitution.

36: Read *hamiçiya°m*, with very slight traces of the last two characters.

38: Weissbach, *KIA* 94, reads $an^u uv^a$-$a\theta^a a$ from Stolze's photograph, and regards the second character as dubious; Herzfeld reads $af^a uv^a ay^a a$ and emends to $ar^u uv^a a\theta^a a$ = *aruvāθā*, which I formerly accepted. The Schmidt photo, as read both by Cameron and by me, confirms Herzfeld's $af^a uv^a ay^a a$ (correction of f^a to r^u by inserting a short horizontal after the vertical, and of y^a to θ^a by adding a vertical hasta, is not to be credited, despite slight illusory marks on the photo). Emend the second character to r^u (with Herzfeld) and read $ar^u uv^a ay^a a$ = *aruvāyā;* for interpretation, see Excursus III.

41: Some traces of the *a* of *tā* which begins the line are visible in the photo.

43: Read *n°uvaniya*, with an unengraved space after the first character.

45: For the interpretation of *ūvnarā*, see Excursus III.

49: The photo shows quite clearly the divider in *navam : tyā*.

49–50: Between these two lines there is vacant space adequate for one line of text; this marks the break in the subject matter. According to the photo, the divider is definitely not at the end of 49, but seems to be visible at the beginning of 50.

50 and 51–52: In both instances the photo confirms $c^a iy^a ak^a r^a m^a m^a c^a iy^a$ (as read by Herzfeld), for -$m^a c^a m^a iy^a$, = *ciyā-karamcamaiy* (transposition of two characters, cf. *Lang.*, XV, 173).

54: Read *ciy : ° āxšnudiy*, the gap being at a considerable cleft in the rock.

55–60: I have attempted some further restorations here, which are not inconsistent with the scanty remains of the Akkadian.

55: Read *marī°kā*.

55 end: There are indications of at least five strokes in the photo (Cameron sees two slight additional strokes in the enlarged photo); but they do not fit Herzfeld's $d^a š^a$ (to which he attached question marks), nor do they fit my own $uš^a$ read from Herzfeld's chart. It seems to me now that the word is the same as that which ends line 52, the lateral space being the same, and that 55 ends with t^a preceded by two (four, according to Cameron) uninterpretable strokes, while the m^a ending the word stood at the beginning of 56, where there is space for it before the (legible) divider. Note, however, that Cameron does not agree with this interpretation of the end of 55.

56: Read *kuna°vātaiy*.

57: The gap may be filled by *nipištam* 'is inscribed', or possibly by *akunavam* 'I have made *or* done'.

58: The photo seems to show $+at^a a$ rather than $k^a r^a t^a$ (which I read from Herzfeld's chart); restore perhaps [*d*]*ātā*.

59: In *ayāumainiš* the character m^a has been omitted in the engraving (Cameron thinks rather that the second *a* or the *u* has been omitted); all other characters are clear in the photo, as is also the *a* of *bavātiy*, which Herzfeld gave in his transliteration but omitted on his chart. My restoration of the final words as [*marīkā : xšāya*]*θiya*, after the Akkadian, is supported by some very fragmentary traces of characters on the photo.

60: The line ends not in $iš^a$, but in in^a :, according to the photo; I take -*ina* as the termination of an accusative plural of an -*in*- stem. The word-divider at the end is very clear. (Cameron expresses doubts as to these readings.)

EXCURSUS I: ON LINES 13–15

As a basis for the present discussion and revision, I first present the text and translation as given in my previous article:

13 *iy : naiy : manauriš : am[iy : ty]āmaiy : ++tana-*
14 *yā : bavatiy : daršam : dārayāmiy : manahā :*
15 *uvaipašiyahyā : darša[m :] xšayamna : a[m]iy [:]*

". . . . I am not revengeful. What things are . . . . to me, those I hold firmly under control. I am firmly ruling over my own temperament."

This text is identical with Herzfeld's (the translation is somewhat different!); his discussion of and decision for the reading *manahā*, in which the character *hᵃ* is slightly uncertain, are given in *ApI*, pages 240–42. He pronounces *manahā* to be "regelmässiger genitiv eines *-ah-* stammes," though admittedly the first recorded example of the type; since OP **manahă* would properly correspond to Skt. gen. *manasas*, he seeks to justify the long final vowel of *manahā* on the ground that the writing "entspricht den zwei üblicheren der drei formen für den gen. der *-āh-*stämme: *-āhā*." Now the sole examples of *-āh-* stem genitives in OP are those of the divine name Ahuramazda: *Auramazd-āha -āhā -āhā*.[2] Occurrences:

	-āhă	*-āhā*	*-āhā*
In inscriptions of Darius...	40	12	0
In inscriptions of Xerxes...	6	2	6

This definitely controverts Herzfeld's dictum as to which forms are the commoner. Further, the shift from *-āhă* to *-āhā* (for which *-āhā* is only an error of writing) is a partial assimilation to the declension of *-ā-* stems:

	-ā- Stems	
Nom. sg.....Skt. *-ā*	OP *-ā*	
Acc. sg.....Skt. *-ām*	OP *-ām*	
Gen. sg.....Skt. *-āyās*	OP *-āyā*	

One can hardly imagine this paradigm as affecting a neuter *-as-* stem (OP *-ah-*); for the three cases, note Skt. *-as -as -asas*, OP *-a -a -aha*. Further, an acc. *nāham* to *nāh-* 'nose' is actually found in OP, showing that no shift took place in this case-form of this word (other forms of OP *nāh-* do not occur in the extant texts). Finally, we have two genitives of consonantal stems in OP, both ending in *-ă*: *piça* (from **pitras*) to nom. *pitā* 'father', and *θarda* to stem *θard-* 'year', both keeping the short vowel.

There is, then, no basis for an analogical extension of *-ā* as genitive ending of neuter *-s-* stems in OP; and *manahā* is not genitive as taken by Herzfeld, but instrumental, = Skt. *manasā*. Then the unmistakable genitive *uvaipašiyahyā* is not an adjectival modifier of *manahā*, as Herzfeld takes it, but a substantival genitive depending upon *manahā* or upon the participle *xšayamna* 'ruling'. In the Avesta the verb *xšā(y)-* 'be able, be powerful, rule' governs the genitive; in the OP passage we therefore expect *xšayamna* 'ruling' to govern the gen. *uvaipašiyahyā* rather than the instr. *manahā*. Another feature confirms this: if *xšayamna* governs the instrumental *manahā*, then *uvaipašiyahyā* must be a genitive depending upon *manahā* (as indeed I took it in my previous article). But there is in the OP texts no genitive in genitive function[3] which follows the noun or adjective on which it depends, apart from a few technical formulas of government and reli-

	-ās- Stems (OP *-āh-*)	
Skt. *-ās*	OP *-ā*	
Skt. *-āsam*	OP *-ām*	for **-āham*
Skt. *-āsas*	OP *-āhā*	for *-āha*

[2] The name of Xerxes, nom. *Xšayāršā*, acc. *-āṃ*, gen. *-āha* (*-ahyā* under Artaxerxes I and later), seems to be similar, but never has gen. *-āhă*; also, it is an *-an-* stem, cf. Av. *aršan-* 'male' for second element.

[3] But the genitive form in dative function may follow; thus I take *Kabūjiyahyā* as dative in ule rather than genitive, in DB 1.30 *hamātā hamapitā Kabūjiyahyā* 'having the same mother and father along with Cambyses'.

gion,[4] and a few pronouns whose position is fixed by the rules of enclisis or the need of clarity.[5] We must therefore take *uvaipašiyahyā* as depending directly upon *xšayamna*, and regard *manahā* as an instrumental in one of the normal uses of that case. But this does not determine whether *manahā* is part of the following clause, or belongs with the preceding. To form an opinion on this we must make a fresh start from another point.

The relative clause of lines 13–14 obviously holds, in the mutilated word, either a plural adjective or a locative singular noun; the meaning is either "what things are . . . . to me" or "what things are in my . . . . ". The mutilated word begins with two lost characters, the second of which had as its final stroke a vertical hasta; its fourth character seems to have been n^a, though the traces are faint (possibly y^a,[6] as Cameron suggests, but not *i*, which is Herzfeld's alternative, *ApI*, p. 333). For the second character the possibilities are x^a, t^a, θ^a, b^a, m^a, r^a, l^a, z^a (those with inherent *i* or *u* are out of the question, since the next character is a consonant): with some hesitation I propose [*dar*]*tanayā*,[7] loc. of *dartana-* 'anger', an extension of OP **darta-* = Av. *zarəta-* 'erzürnt,' ptc. to the Av. root *zar-* 'erzürnen', pIE **ĝher-* or **ĝhel-*, seen also in Skt. *hṛ-ṇīté* 'is angry', with the secondary suffix *-na-*.[8] The clause means then approximately "what things are *or* develop in my anger", with the continuation "(these) I hold firmly under control". The harmony of this with the Akkadian version, which is indeed the basis for the proposed restoration, will be seen later.

After I had written the preceding paragraph, Cameron examined the enlarged photograph and in it found the lowest of the three short horizontals which, with the following vertical hasta, make up the character r^a. For this reason I feel justified now in transcribing not [*dar*]*tana-* but [*da*]*rtana-*.

To return now to *manahā*: whether it goes with the preceding or with the following, it is obviously used in a good sense, despite *manauviš* 'revengeful' (or the like). Etymologically, OP *manah-*, Av. *manah-*, Skt. *manas-* all mean 'thought, thinking power'. Bartholomae, *Altiran. Wörterb.*, col. 1126, defines Av. *manah-* as " 'der innere Sinn, Geist; Denken, Gedanke; Streben, Begierde; Plan, Anschlag'." The meaning seems to indicate that *manahā* goes with the preceding, and to be, in effect: "what I actually allow myself to say in anger, I keep under control by my thoughtful will-power; I do not in haste say that which in more thoughtful moments I may regret to have said." To this there is added the summarizing clause, "I am firmly ruling over that which is my

[4] These are *xšāyaθiya xšāyaθiyānām* 'king of kings', *xšāyaθiya dahyūnām* 'king of countries', *hya maθišta bagānām* 'the greatest of the gods', *vašnā Auramazdāha* 'by the favor of Ahuramazda'. These may represent a Median usage, established in the official language before the Median line was replaced by the specifically Persian line in the person of Darius.

[5] These are DNb 25–26 *anur taumanišaiy* (= *-išaiy*) 'according to his powers'; A^{2}Sa 3 *apan^{a}yāka-ma* (for *-maiy*) 'my great-great-grandfather', 4 [*n^{a}y*]*ākama* (= *-kam-maiy*) 'my grandfather'; and three heavily restored passages, DB 5.27 [*maθ*]*išta*[*šām :*] *S*[*ku*]*za : nāma*, DSf 20 [*ava : dastāmaiy : naibam : ucāram*], DSf 23 [*hacāci*]*y : dūradaša* [*: arjanam-šaiy : abariya*]. In the second it would be possible to restore *ava-maiy : dastā*, but the available space seems to render any similar transposition impossible in the other two.

[6] If the character is really y^a, then the text could be restored [$d^a r^a$]$t^a y^a$- ‖ $y^a a$ = *dartayā*, with dittography of the y^a; loc. of neuter ptc. as subst. 'anger', = Av. *zarəta-* 'erzürnt'.

[7] Or possibly [*zar*]*tanayā*, with Median *z* from IE *ĝh* (as also from *ĝ*), as in a number of OP words (Meillet-Benveniste, *Gram. du Vieux-Perse*^{2}, § 9); the *z*-would provide distinction from derivatives of OP *dar-* (IE **dher-*) 'hold firm'.

[8] I cannot give a precise parallel to the combination of participle in *-ta-* + suffix *-na-*, but it does not seem to me an improbable combination. Av. *šyaoθna-* 'deed', Skt. *cyautná-* 'undertaking,' to the Aryan root **cjav-*, approximates this, but has *-t-na-* and not *ta-na-* (it is impossible to normalize OP *dartnayā*, since *tn* cannot stand unchanged in Iranian: Aryan *-tn-* became Iranian *-θn-*, Av. *θn-*, OP *-šn-*).

own," = "I am in complete control of myself and of what I say."

It remains to reconcile this meaning of *manah-* with the obviously bad meaning of the derivative *manauviš*, 'revengeful' or the like. Herzfeld, *ApI*, page 242, takes *manauviš* as an adjective in *-i-*, derived from the stem *mana-* with a *u*-extension, and having the meaning 'irae memor, iracundus', which he finds justified by the Akk. *ul man-ma ša igāga anāku* 'ich bin nicht einer der *igāga* zürnt, wütet'. On page 241 he takes *manah-* as the equivalent of Gk. *μένος* 'energie, wut', and not in the good meaning which pertains to Avestan *manah-*. *Manauviš* goes back, he says, to the same root as *manah-*, but is not directly derived from it, though the meanings agree.

On the other hand, I take *manauviš* to be for *manah-* + the adj. suffix *-vin-*; this suffix is in Skt. in most instances added to stems in *-as-* (Whitney, *Skt. Gram.*[3] § 1232), though Skt. **manas-vin-* does not actually occur: cf. *Lang.*, XV, 170. The difference between *manauviš* 'revengeful' or the like, and *manah-* 'willpower', is paralleled by English *wilful* from *will*, *temperamental* from *temperament*, *sensual* as adjective to *senses*, *temper* as contrasted with *temperate*. I assume the same pejorative development in the OP adjective *manauviš*, which I take to mean 'wilful', or in the present passage more precisely 'hot-tempered'.

The Akkadian version of this passage, in Herzfeld's transliteration (*ApI*, page 6), is as follows, which I here divide into three sentences for ease of equation with the OP:

(1) *ul man-ma šá i-ga-a-ga ana-ku*
(2) *u ki-°-i a-ta-ag-°-ga i-na lib-bi-ja u-kal-la*
(3) *ina muḫḫi lib-bi-ja ra-ba-a-ka*

Herzfeld's translation of the composite OP-Akk. text, with OP *manahā* going with the following, is:

(1) "Ich bin nicht rachsüchtig:
(2) die mir [akk.: zornig?] werden behalte ich fest,
(3) und meiner eignen leidenschaften bin ich streng herr."

Cameron's translation of the Akkadian alone, communicated to me by letter, is:

(1) "Not one who (easily) becomes angered am I,
(2) but (*or* and) when I do become angry I hold (it) back in my heart;
(3) (for) upon (= over) my heart I am master."

Both Cameron and my colleague Z. S. Harris, whom I consulted long since on the point, take *i-na lib-bi-ja* of Part 2 as representing OP *manahā*, which therefore belongs to Part 2. The corollary is that *ina muḫḫi lib-bi-ja* corresponds to OP *uvaipašiyahyā*, and to nothing more.

The Akkadian version therefore supports my restoration [*da*]*rtanayā* and its translation, and the taking of *manahā* with the preceding: "I am not hot-tempered. What things develop in my anger, I hold firmly under control by my willpower. I am firmly ruling over my own (impulses)."

EXCURSUS II: ON LINES 33–40

To lines 33–40 of the OP there correspond lines 21–24 of the Akkadian version, in each of which there is an illegible gap at about the three-quarters mark, capable of holding from two to five characters. It was clear to Herzfeld, when he made a synoptic text of the OP and the Akk., that some of the OP words and phrases were omitted in the Akk. version, and he divided the omissions into two passages, without giving any motivation for the error. But Cameron, when he compared the two versions, arrived at a different arrangement, which through his kindness I am privileged to present.

In the following, the OP text is divided

into nine parts, labeled A to I, each accompanied by Herzfeld's parallel Akk. text and his composite translation of the OP-Akk. texts (Akk-H), and then by Cameron's arrangement of the Akk. text and his literal translation of the Akk. only (Akk-C).

A: OP *tyamaiy tanūš tāvayatiy*

Akk-H [ ]-*na ra-ma-ni-ia ga-áš-ra-ak*
So sehr es mein Leib es vermag,

Akk-C [*i*]-*na ra-ma-ni-ia ga-áš-ra-ak*
In my own body I am strong;

B: OP *hamaranakara amiy ušhamaranakara*

Akk-H *e-piš ta-ḫa-zi ma-di-iš a-na-k*[*u*] *ina qab?-la ta-ḫa-zi*
bin ich als krieger ein guter krieger.

Akk-C *e-piš ta-ḫa-zi ma-di-iš a-na-ku*
a maker of battle very greatly am I.

C: OP *hakaramciy ušīyā gāθavā vainātaiy*

Akk-H *iš?-tum?* *igi-gál-na-a* = *uznā-a i-na mil-ki dib-bi-ia*
Wenn es meinem verstand zweifelhaft erscheine,

Akk-C [. . . .] *ina qab -la ta-ḫa-zi*
In the midst of battle,

D: OP *yaciy vaināmiy hamiçiyam*

Akk-H [omission in Akk. text]
wen ich als feind betrachten,

Akk-C [omitted in Akk.]

E: OP *yaciy naiy vaināmiy*

Akk-H [*q*]*a?-at ra-ma-ni-ia*
wen ich (als) nicht-(feind) betrachten soll,

Akk-C [omitted in Akk.]

F: OP *utā ušībiyā utā framānāyā*

Akk-H *i-na* GIŠ-+-*ma ba-na-a*
"Vor verstand und urteil"

Akk-C *iš-*[*tum?*] *uznā i-na mil-ki dib-bi- aḫ*
out of (my) understanding, (and) in (= with) the council of my word (= command)

G: OP *adakaiy fratara maniyaiy aruwāyā*

Akk-H [omission in Akk. text, to
alsdann "zuerst" denke ich "ist die güte",

Akk-C +-+-+-*at ra-ma-ni-ia i-na* [*ūmi-šu*]-*ma ba-na-a*
[the deeds (?)] of myself at that time are fashioned,

H: OP *yadiy vaināmiy hamiçiyam*

Akk-H here] *ma-am-ma ni-ik-ri*
auch wenn ich als feind betrachte,

Akk-C *ma-am-ma ni-ik-ri*
(when) anyone hostile

I: OP *yaθā yadiy naiy vaināmiy*

Akk-H+ + + + + *u*]-*ta-am-ma-ri*
als ob ich (als) nicht-(feind) betrachte.

Akk-C ˹*ki*˺ [*la ni-ik-ri*] *u-ta-am-ma-ri*
as not hostile I see.

Through this passage the OP text is quite certain, with the exception of the word ending Part G, which Herzfeld emends to *aruvāθā* and I to *aruvāyā* (see critical note, page 44). To Herzfeld's interpretation I would make several objections: he appears to omit entirely Akk. *ina qab-la ta-ḫa-zi* in B, unless he takes it as a virtual repetition of the preceding (but the Akk. does not have the repetitions which are a feature of the OP in this clause and elsewhere); his "zweifelhaft" in the translation of C seems to be unjustified; his masculine "wen" in D and E corresponds to neuter *yaciy* in the OP; he takes his *aruvāθā* (his normalization, *'rvāθā*) as nom. sg. fem., to which *fratara* is predicate—but *fratara* is nom. sg. masc. He further assumes two omissions in the Akk. text, the first being that of Part D and the second being that of G and the first word of H. Cameron's equation of the two versions is much more reasonable, since he assumes only one omission in the Akkadian, covering D and E; and the omission is motivated by the fact that D and E are virtually repeated by H and I. In fact, if the OP text of D and E were omitted, we should not be prevented from arriving at the proper interpretation of the whole passage. Cameron sets in C, F, G the Akk. text which Herzfeld sets in B

(end only), C, E-F respectively; he makes the obviously correct restoration in the gap in the Akk. of Part I. Further, he notes that in A there is no space for a subordinating word corresponding to OP *tya*, between *i-na* and the ^{tu}*it-ba-ru-ta-*[*a* which ends the preceding sentence, and that in the Akk. there is no subordinating word corresponding to the OP *yadiy* at the beginning of H; and he offers a partial restoration of the Akk. of G.

I have already remarked that Herzfeld's interpretation of much of the passage is quite unsatisfactory (he had, of course, the disadvantage of being the first to undertake here any complete interpretation at all). The most important point at which Cameron's synoptic text needs detailed discussion, is in Part C, where Akk. *ina qab-la ta-ḫa-zi* 'in the midst of battle' becomes the translation of OP *gāθavā* 'in (its) place'. Herzfeld read $g^{a}a[\theta^{a}uv^{a}]a$ = *gā*[*θuv*]*ā*, which he took (*ApI*, page 179) as loc. dual, 'an zwei plätzen, = zweifelhaft' (!), disregarding his own equation of the word with Akk. *i-na mil-ki dib-bi-ia* 'in the advice (*or* council) of my word'. Now OP *gāθu-*, with *θ* generalized from case-forms in which consonantal *v* immediately followed, is the exact etymological equivalent of Avestan *gātu-* (Bartholomae, *AiW*, col. 517), Skt. *gātu-*. Skt. *gātu-* means 'moving, moving-place, place, abode'. Avestan shows only the developed meanings: 'Ort, Platz, Stätte, Stelle; festbestimmter, vorgeschriebener, richtiger Ort, usw.; Ort des Gerichts, Gerichtshof, Forum; Stätte zum Ruhen, Liegen, Sitzen, sva. Lagerstatt, Bett, Divan, Sessel, Thron'. In giving these meanings, Bartholomae, I think, goes into rather too much detail; the word itself means hardly more than 'place, suitable *or* appropriate place (as indicated by the context)'. Notably, the meaning 'Ort des Gerichts, Gerichtshof, Forum' occurs only in one passage (*Frahang* 4 c; in part repeated in 4 d), 'whoso, to a man contesting at law, shall not appoint (*or* communicate) the *place* and the test and the time'; this Avestan passage and the Akk. *i-na mil-ki dib-bi-ia* caused me (in *Lang.*, XV, 168) to translate OP *gāθavā* in our passage, by 'council'. But OP *gāθu-*, like its Avestan equivalent, means only 'place', with such specializations as the context may suggest; an English possessive always makes this clear (OP never has a possessive adjective and has a genitive only in XPf 35, where the meaning requires it):

DB 1.62–63, 66, 69: 'I re-established (*avāstāyam*) it (the kingship) in its place .... the people in their place .... our royal house in its place.'

DNa 36: '.... (this earth in commotion)..... I set it down (*niyašādayam*) in its place.'

XPh 34: 'that province (which was in commotion) I smote, and I set it down (*nīšādayam*) in its place.'

DSe 37, 43–45: 'I brought it about (*akunavam*) that .... each one (of those previously fighting) is in his place .... much which previously had been put (*kartam*) not in (= out of) its place, that I put (*akunavam*) in its place.'

In the remaining passages, apart from the one which we are discussing in DNb 35, *gāθu-* 'place' means 'throne':

DNa 41–42: 'See the sculptures (of those) who bear my place (= throne).'

XPf 33–36: 'When my father Darius went away from his place (= throne, i.e., died), by the favor of Ahuramazda I became king in the place (= on the throne) of my father.'

In DNb 35, our Part C, as well as in the other passages, the meaning should be determined by the context. This context has to do with Darius as a fighter in battle, seeing and discriminating between the rebel (*hamiçiya-*) and the nonrebel. Thus we also reach, by consideration of

the OP alone, Cameron's conclusion that *ina qab-la ta-ḫa-zi* 'in midst of battle' represents *gāθavā* 'in the place (of battle)', which refers back to Darius' assertion, 'As a battle-fighter I am a good battle-fighter'. The sentence accordingly means: 'Once let there be seen with understanding in the place (of battle) what I see (to be) rebellious, what I see (to be) not-(rebellious); with understanding and with command then I am first to think with action, when I see a rebel as well as when I see a non-(rebel).' Whether we say 'rebellious' or 'hostile', and 'rebel' or 'enemy', is of little consequence; for to Darius the ideas were synonymous: to him who had received the rulership of the entire world by the favor of Ahuramazda, any hostility was an act of rebellion, and any enemy was a rebel.

At the end of the Akkadian of G, as arranged by Cameron, *banā* may have the more usual meaning 'are fashioned' rather than 'are good'. It is irrevelant here whether there are two distinct roots *banū*, or only one root with two meanings (cf. Poebel, *ZfA*, XXXVIII [1929], 91, n. 1).

One more point here: In 'I am first to think with action' the OP uses the comparative for 'first', and more precisely, but less literally it means 'I turn thought into action before the other man, be he enemy or be he friend, can turn his thought into action.' For *fratara maniyaiy* is merely the idiom seen in Latin *prīmus vēnī* 'I came first, was the first to come': here *prior cōgitō* 'I am the prior to think.' On the meaning of *aruvāyā*, I refer to Excursus III.

EXCURSUS III

ON *aruvastam*, *aruvāyā*, *ūvnarā*

In DNb 4, *aruvastam* was read long ago by Rawlinson, as he records in *JRAS*, X (1847), 312–13, from Westergaard's manuscript copy, and again by Weissbach (cf. *KIA*, page 92) from photographs: *aruvastam* in 33 was also reasonably clear to Weissbach, and *anuvāθā* or *afauvāθā* in 38. The reading of *aruvastam* in 31, of *ūvnarā* in 45 and of the mutilated *ūv*[*naraibiš*] 48 and *ūv*[*narā*] 51 had to wait for Herzfeld's re-examination (published in *ApI*); some further improvements are, I hope, to be found in the present reading of Schmidt's photographs, where I seem to see traces of some additional characters, and to be able to justify *aruvāyā* (rather than Herzfeld's emendation to *aruvāθā*).

The late A. V. W. Jackson, in *JAOS*, XXXVIII (1918), 123, noted that previous scholars had suggested an approximate meaning of 'sovereignty' for *aruvastam*, and himself proposed to derive it as a neuter abstract formed with the suffix *-ta-* to the stem seen in Avestan *aurvant-* 'lordly, princely, sovereign' and in Skt. *arvant-* (such derivatives are formed upon the stem in *-vat-*, containing the weak grade of the suffix); cf. Av. *ašavasta-* 'quality of being righteous', to *ašavant-* 'righteous'.

To Jackson's etymology no exception can be taken, so far as derivation and phonetics are concerned; but Av. *aurvant-* (in which the *u* is only a labialization caused by the *v* after the *r*, so that an earlier *arvant-* is assured) is defined by Bartholomae, *AiW*, col. 200, as 'schnell; tapfer, Held; . . . . von *Haoma;* . . . . bes. vom Ross; Renner', and hardly furnishes the basis for the meaning 'sovereignty', which Jackson accepts. Skt. *árvant-* is defined by Monier-Williams as 'running, hasting; courser, horse; the driver of a horse; a part of a sacrificial action', all these meanings in the Rigveda, with other meanings in later literature. Quite clearly *arvant-* is a primary adjective formed upon the verbal root Skt. *ṛ-* 'go, move', Av. and OP *ar-* of the same meaning, seen also in Latin *orior* 'arise'; the primary meaning is 'going, moving, flowing', and the like. For

the abstract *aruvastam*, then, some meaning such as 'activity' seems likely, which pairs off very well with (acc.) *xraθum* 'wisdom' (exact meaning assured by the Akk. equivalent, *ṭè-e-me ḫi-is-sa-tum* 'word *or* message of wisdom') in line 3.

Now Herzfeld, who (*ApI*, pages 6–7) was the first to read the Akk. text, notes the following correspondences:

OP *aruvastam* (his *ār^{u}vastam*)	= Akk. *^{tu}it-ba-ru-tum*
OP *aruvāyā* (his *'r^{u}vāθā*)	= Akk. lacking
OP *ūvnarā* (his *ₐu^{v}narā*)	= Akk. *^{tu}it-ba-ru-ti*

His discussions of the words are in *ApI*, pages 80–86, 293–96, 200–206; he equates *aruvastam* in meaning with Avestan *vohū manō* 'Good Thought', and *uvnarā* with Av. *yaoxštayō* 'devices, skills'. He sees an obvious etymological association between *āruvastam* and *'r^{u}vāθā* (his readings and normalizations) and connects them with a conflux of two groups of words found in the Avesta: Gāthic *^{u}rvāta-*, cf. Skt. *vratá-* 'bestimmung, gebot', etc., and Gāthic *^{u}rvāθā-* 'Liebe', Later Av. *^{u}rvaθa-* 'amicus', *a-^{u}rvaθa-* 'inimicus'—whose radical meanings 'word, rule' and 'will, choice' easily pass over into each other. As between the two, however, the OP words come rather from the second, and mean respectively 'gut-sein' and 'liebe'. In confirmation of this, *āruvastam* is translated into Akk. by *itbarūtum* 'friendliness' (Cameron's translation), a derivative of *ibru* 'friend'.

Against Herzfeld's views there is the serious objection that the Avestan words beginning with *urŭ-* and *urv-* come from earlier forms with *ru-* or *ruv-*, *sru-* or *sruv-*, and *vr-* metathesized to *rv-* (whence *urv-*; a vowel always follows). There is no evidence that any of these initials would give in OP an initial *a-r^{u}-u-v^{a}-*, nor that in such a case the initial *a* would stand for the long vowel in the one and for a mere glottal catch (Herzfeld's ') in the other. If Herzfeld's etymology is right, we should expect *r^{u}-u-v^{a}-*, in which the *u* would be syllabic and not merely graphic, as Herzfeld takes it. Further (henceforth I resume my own system of normalization), the medial vowel in the Avestan word for 'friendly' is always short, not long as in OP *aruvāθā*. But there remains the difficulty of reconciling *aruvastam* 'activity' with Akk. *itbarūtum* 'friendliness': my suggestion is that the one means '(friendly) activity' exercised in behalf of one's companions, and the other means '(active) friendship' expressed in deeds. This is in harmony with the total meaning of the passage, neither word expressing with precision the implied limitation to the normal meaning. Finally, I note that Herzfeld says (*ApI*, page 201): "Die inschrift spricht zuerst vom *xraθum utā ārvastam*, nimmt das durch *uši utā framānā* auf . . . .'; in his German version he uses 'göttliche weisheit und gut-sein' and 'verstand und urteil'. If they are to be paired off in this fashion, my own 'wisdom and activity' seems to be better resumed by 'understanding and command'; for wisdom, whatever its source or its nature, makes possible the understanding of the situation in hand, and activity is expressed in commands to one's subordinates, as well as in one's own physical actions.

OP *ūvnarā* 'skillfulnesses, skills' is a neuter adjective as substantive; it is quite appropriately etymologized as an adjective formation with *-a-* suffix, formed upon **su-* 'good' + **nar-* 'man', with lengthening of the vowel of the initial syllable to show the derivational character: 'having the good qualities (*or* a good quality) of a man'. In its OP specialized meaning it diverges from the etymologically identical Skt. *sū-nára-* 'glad, joyous, merry'. Avestan *hunara-* is a substantive glossed by Bartholomae, *AiW*,

col. 1831, with 'Können, Kunst; Kunstfertigkeit, Geschicklichkeit; Tüchtigkeit, persönlicher Wert'; probably neuter, despite Bartholomae's labeling as masculine (inst. *-rā*, gen. pl. *-ranąm*, acc. sg. *-rəm* each occur once, and are ambiguous as to gender). Its derivative *hunaravant-* 'kunstfertig, geschickt, tüchtig' occurs twice, and in both passages is applied to women: Herzfeld (*ApI*, page 201) brands derivation from *hu-nar-* 'good-man-' as a folk-etymology only, mainly because *hunaravant-* is applied to women only whereas **nar-* means a male human being. He seeks to develop another etymology (*ApI*, page 206), but not convincingly; and his objection to the obvious etymology falls, because the adjective had already acquired its derived meaning before it was applied to women, and at most a mixed metaphor could be alleged.

Of our three words, there remains (Herzfeld's) *aruvāθā*, or as I now read it, *aruvāyā*. The unlikelihood of Herzfeld's connection with Av. *urvaθa-* 'friendly', from the phonetic standpoint, has already been mentioned. Further, granted that *aruvastam* is a derivative of the stem in Av. *aurvant-*, Skt. *arvant-*, and that *aruvastam* and *aruvāθā* are extensions of the same element, the long medial vowel and the aspirated consonant of the suffix in *aruvāθā* are difficult to explain. I therefore prefer to retain the y^a which is on the rock, rather than emend the character to θ^a; the second character must however be emended to r^u. The word is then *aruvāyā*, which I take as instrumental of fem. adjective *aruvā-* as nomen actionis; for Avestan has an adjective *aurva-* 'schnell, tapfer' paralleling *aurvant-*. The difference between OP *aruvasta-* and OP *aruvā-*, if definable, may have been that the former was the general quality of being *arvant-*, the latter the specific realization of the quality: respectively 'activity' and 'action'. This realization as 'action' is the meaning which is to be understood for *aruvāyā* in the concluding paragraphs of Excursus II.

The picture of Darius as he presents his own qualities now becomes consistent with his own record of his deeds. Darius portrays himself as the exemplar of Persian ideals of conduct, the earthly deputy (DSf 16–18, etc.) of the supreme deity Ahuramazda. Throughout the inscriptions he is the mighty ruler to whom resistance is treason, who puts to death with or without torture those who would set themselves in his place and those who are the prominent followers of such rebel leaders; he also rewards those who are loyal and faithful and perform his commands. He praises the doers of right, the worshipers of Ahuramazda; he condemns the doers of wrong, and those who fail to worship Ahuramazda. In all this there is no mention of the Christian qualities of love, mercy, pity, forgiveness, to be shown toward enemies; it is out of place then to see such virtues in *aruvastam* and in *aruvāθā* or *aruvāyā*, which, Darius says, he thought of more quickly than did the other fellow, as much when he saw an enemy as when he saw a friend. No; Darius did not show 'love' (Herzfeld, *ApI*, page 244, top) to his enemies—had he done so, he could hardly have lived to sit upon the Great King's throne for thirty-six years.

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I KINGS 7:20

WILLIAM A. IRWIN

THE description of the building of Solomon's temple provides some of the most difficult Hebrew in the entire Old Testament. This is in large part due to our ignorance of the architectural terms in use by the author but beyond question also to textual corruption, doubtless indicating that our ignorance was shared by many scribes of antiquity. Verse 20 of chapter 7 is one of the most perplexing passages in these two chapters of difficulty. It is commonly believed to be corrupt to the point of unintelligibility. Gressmann, for example, retains only part of verse 19 and omits all of verse 20 with a note, "Der Rest von V. 19 und 20 spottet jeder Erklärung."[1] Kittel attaches 20*b* to a revised text of a remnant of 18, then retains of 20*a* in its proper place only the first four Hebrew words.[2] Burney is more hopeful, for he undertakes to expound certain phrases, merely noting "peculiarities of this verse in LXX."[3] Perhaps there is no better exposition of the difficulty of the verse than the translation of the American Standard Version, reasonably literal and accurate as it is:

> And there were capitals above also upon the two pillars close by the belly which was beside the network: and the pomegranates were two hundred, in rows round about upon the other capital.

Any attempt to visualize a rational construction from these words will show at once why commentators have commonly taken the easy course of ignoring the verse. What was this "belly" somewhere close to the capitals—or the pillars? And how was it "beside the network"? And, to add to the confusion, the preparation of the capitals for the tops of the pillars has already been related (vs. 16), and the making of the nets (vs. 17). The place and the function of the latter are described merely as "for" (ל) the capitals, but certainly they were not to be set off somewhere "beside" a "belly" that in turn was only "close by" the capitals.

A first step toward a discernment of rationality in the account is taken when we recognize that mention of the capitals at the outset is merely the resumption of a theme that has been interrupted by details of the nets and pomegranates: briefly the words וכתרת אשר על־שני העמודים גם־מטעל are a *casus pendens*, not a nominal sentence; the structure is parallel to that in verse 19.

Now, further, whatever we are to make of the phrase "close by" (מול־עבית), the "belly" can be nothing else than the rounded surface of the capital itself. And the common view is patently correct that the "nets" were decorations hung around or cast with the surface of the capitals. Briefly, the word לעבר, translated in the ARV "beside" but more properly "opposite," here means "corresponding to," "fitting the surface," more simply, "upon the surface." This will not strain its common meaning but merely give a special application to fit this technical passage. And the force of מול־עבית, "close by," is similar; it means "beside." But how near or far must one have an object for it to be "beside"? Can it be in contact?

But all this has been told in verses 16–18. It is possible, indeed, that we have here but a case of tiresome redundancy, as most commentators believe. But equally it is possible that the author was citing these features, already presented in detail, in order to clarify the basis for his further statement. And this statement would then follow in the balance of the verse. But it is separated both by the presence of *athnaq* and by an introductory *waw*. Yet neither of these considerations is conclusive. The massoretic punctuation is certainly wrong in places—at the best it was only the opinion of men a thousand years and more re-

[1] *Die Schriften des Alten Testaments*, II, 1.

[2] *Handkommentar zum Alten Testament*, *ad loc.*

[3] *Notes on the Hebrew Text of the Books of Kings*, *ad loc.*

moved from the authors. And *waw* has a number of uses quite diverse from the force of English "and"; in addition to its explicative meaning, it introduces, not uncommonly, the predicate with a sort of emphatic or determinative force. If we may so regard it in this case and remove *athnaq* to סביב and put *zaqeph* on ויגעל, we secure a meaning that is at once lucid and relevant:

As for the capitals on the tops of the two columns (literally, upon the columns even above): along the rounded surface, upon which was the network, there were two hundred pomegranates in two rows round about; and so on the other capital.

Even so, the verse seems to be 90 per cent a repetition of facts already given. True; but its new feature is that it makes clear the location of the nets, a matter that previously had been only inferred.

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CORPORATE PERSONALITY IN JOB: A NOTE ON 22:29–30

ROBERT GORDIS

IN HIS stimulating paper on "The Sources of the Suffering Servant Idea,"[1] Professor J. Philip Hyatt follows H. W. Robinson in calling attention to the widely prevalent conception of "corporate personality" as a source for Deutero-Isaiah's thought.[2] Particularly welcome is Hyatt's emphasis upon what we may call the positive aspect of the doctrine, that not only punishment, but salvation as well, may accrue to the group from the actions of the individual.[3]

This insight, at which we arrived independently, is the key, I believe, to the enigmatic passage in Job 22:29–30, with which Eliphaz closes his fourth and last address to Job:

כִּי הִשְׁפִּילוּ וַתֹּאמֶר גֵּוֶה וְשֵׁחַ עֵינַיִם יוֹשִׁעַ
יְמַלֵּט אִי־נָקִי וְנִמְלָט בְּבֹר כַּפֶּיךָ׃

The difficulties scholars have encountered in this passage may be studied in detail in the commentaries. Thus verse 29 has been rendered: "If they lowered you" (Rödiger, Hitzig), or "If your ways are depressed" (Ewald, Delitzsch, Dillmann), "You say 'Rise up,' and He will save the humble [i.e., Job]."

Other commentators refer the promised salvation, not to Job, but to the innocent in general, but then find difficulty in *ʾîy nāqîy*. They therefore emend it to *ʾîš nāqîy*, "an innocent man" (Reiske, Dathe). A far-fetched attempt to extract this meaning from the Massoretic Text is to interpret it as "one unjustly condemned (but innocent)" (Rabinowitz-Abronin).

The obviously unsatisfactory character of these interpretations has led to a plethora of emendations, among the best of which are: *kî hišpîl ʾômer gaʾawāh* (Duhm); *kî hišpîl ʾet rām wᵉgēʾeh* (Beer); and *kî hišpîl rōmeh gĕwoh* (Hoelscher). After an extensive discussion, Driver-Gray (*I.C.C.*, I, 198–99; II, 157–58) adopt Budde's emendation for 29*a*: *kî hišpîl ʾelōah gaʾawāh*, and in verse 30 read: *yimmālēṭ ʾîš nākîy wattimmālēṭ bᵉbᵉʾōr kappekᵉa*. Nonetheless, they are constrained to admit that, "even as emended, the text is not a very forcibly expressed conclusion to the speech."

When, however, the entire passage is understood in terms of traditional Hebrew thought, it constitutes a powerful close to Eliphaz's address, without the need of radical emendation. Like all the Friends, Eliphaz stands foursquare upon the ancient doctrine of corporate responsibility, against which Jeremiah (31:20–21) and Ezekiel (14:12 ff. and chapter 18) inveighed (cf. Job. 5:4–5; 8:15, 22; 21:19*a*).

[1] *JNES*, III (April, 1944), 79–86.

[2] Cf. Robinson's fundamental paper, "The Hebrew Conception of Corporate Personality," *Werden und Wesen des Alten Testaments* ("BZAW," Vol. LXVI [1936]), pp. 49–62). A significant development of several phases of this basic outlook will be found in Aubrey R. Johnson, *The One and the Many in the Israelite Conception of God* (Cardiff, Wales, 1942), pp. 6–17.

[3] *Op. cit.*, p. 80.

This idea had, as we have noted, its positive as well as its negative aspects. In addition, it was not only "vertical" but also "horizontal," that is to say, it operated in space as well as in time, so that a righteous individual could save not merely his descendants but also his contemporaries. That is the basis of Abraham's appeal to God to save Sodom for the sake of ten righteous men and Ezekiel's citing of the doctrine, to which he objects, that the presence of Noah, Daniel, and Job in a city could save it from destruction (14:14 ff.). Another case in point is Job's prayer for his friends (42:8, 10).

This doctrine never disappeared from Judaism. Even after the idea of individual responsibility was accepted, it continued in the idea that a saint could even set aside God's decree, as in Talmud Babli, *Moed Katan*, 16*b*: "Said the Holy One, blessed be He, 'I rule over man, but who rules over Me? The Saint, for when I issue a decree (*gōzēr gᵉzērāh*), he sets it aside.'" The same idea persisted in the widespread Jewish folk belief of the thirty-six saints whose lives glorify God's presence and preserve the world from ruin (*lamed-vav ṣaddikim*).[4]

It is from this standpoint of "horizontal" corporate responsibility that Eliphaz speaks. A righteous Job will not only be restored to personal safety (22:21, 23) and prosperity (22:25) but will also regain his great influence among men and with God. His mere word will suffice to save those humbled in society, and even the guilty will escape divine punishment because of Job's transcendent righteousness. On the juxtaposition of these two ideas—favor with God and man—compare Num. 32:22 ("Ye shall be free from guilt before God and Israel") and Pr. 3:4 ("and find grace and good favor in the eyes of God and man"), for which parallels may also be adduced in Canaanite literature.[5]

Verses 28–30 now require no change in the Massoretic Text, except for the possible, though not absolutely necessary, modification of the vowels in one word. The passage now gives an excellent climax to Eliphaz's speech:

Thou shalt issue a decree[6] and it will be fulfilled for thee,
And light shall shine upon thy ways.
When men are brought low,[7] thou wilt say,
"Rise up!"[8]
And the humble will be saved,[9]
Even the guilty[10] will escape punishment,[11]
Escaping through the cleanness of thy hands.

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[4] Talmud Babli, *Suk.* 45*b*: "The world cannot do with less than thirty-six saints who greet the Divine Presence daily."

[5] Cf. the Phoenician inscription from Memphis in M. Lidzbarski, *Altsemitische Texte* (Giessen, 1907), p. 35, l. 4: *wytn lm ḫn wḫym lʿn ʾlnm wbn ʾdm*, and the inscription of Yeḥawmilk of Byblus in *ibid.*, p. 14; cf. G. A. Cooke, *Textbook of North-Semitic Inscriptions* (Oxford, 1903), pp. 18, 24: *wttn . . . . . ḫn lʿn ʾlnm wlʿn ʿm ʾrṣ z*. I am indebted for these references to my colleague, Professor H. L. Ginsberg.

[6] Note the root *gāzar*, "decide," used in the passage in *Moed Katan* cited above.

[7] The *hiphil* is used intransitively (cf. *hirḥiqu* [Gen. 44:4]; *haśmēn* [Isa. 6:10]). Or, less probably, the clause may be translated, "If they cast men down, etc."

[8] On גֵּוָה as an alternative spelling for גַּאֲוָה, "pride," cf. Jer. 13:17 and Dan 4:34.

[9] Probably to be vocalized as a *niphal*, *yiwašēʿa* (so also Hoelscher). On the other hand, W. A. Irwin suggests in a note to me that the *hiphil* of the MT be retained, either as an indefinite subject equivalent to a passive or that "God" be understood as the subject.

[10] אַי is the negative particle, common in rabbinic Hebrew and normal in Ethiopic. While "Ichabod" (I Sam. 4:21) may originally have been a theophorous name, the biblical author undoubtedly interprets it as containing the negative particle, "No-Glory" (cf. "Saying, 'Glory has departed from Israel'" [*ibid.*]). He thus testifies to the antiquity of its usage as a negative in Hebrew.

[11] The *piel* of the Massoretic Text does not require a change to the *niphal*, since the *piel* may be used reflexively and hence is a virtual passive. Cf. Gen. 41:14, *wayyᵉgallaḥ*; Amos 2:15 *wᵉqal bᵉraglāw lō yᵉmallēt*.

BOOK REVIEWS

The Legacy of Egypt. Edited by S. R. K. GLANVILLE. Oxford: Clarendon Press, 1942. Pp. xx+424. $4.00.

Like the other volumes in the famous "Legacy" series, this is a collection of essays written by a number of experts. Unlike the others, the present volume was brought out when conditions affecting such an undertaking were, owing to the war, at their worst. The editor himself has been in the service of his country, and the difficulties of communication with many of the contributors, some of whom, such as Capart and Seidl, could not be reached, must have seriously handicapped him. That the book has appeared at all and is a valuable addition to the series, is greatly to the credit of Mr. Glanville.

"Legacy" is rightly interpreted in the wide sense. Indeed, it could well be argued that everything which we know now or shall ever learn about ancient Egypt is properly part of her legacy to us. Since, however, it would be impossible to encompass in four hundred pages our present knowledge of Egyptian history and culture, it has been necessary to make a selection. The discrimination exercised by the contributors has been generally excellent, and the book is well rounded, far from sketchy, and eminently readable.

Two chapters, one on chronology and one on the general political history of the Near East from prehistoric times to the classical world, give setting and background for the others. It is unfortunate that the first chapter, by J. W. S. Sewell, must be regarded as by far the weakest in the book. In so far as its aim was that of providing "a few chronological pegs upon which the history of ancient Egypt may be hung," the chapter is successful though arbitrary. A precise date of 3188 for the accession of Menes, on the evidence suggested, is hardly acceptable, but the general accuracy of this date, allowing some leeway plus or minus would be approved by all advocates of the "short" chronology. Again, the precise dating of the commencement of the Twelfth Dynasty to 1990, solely on the basis of the Sothic date of Sesostris III, ignores the lack of adequate data for a determination of the *arcus visionis.* Unless other chronological data are available, any Sothic date can at best be expressed as falling within a twelve-year range.[1]

When, however, the author theorizes on the origins of the calendars of Egypt, the results are far from happy. Few scholars are likely to accept his ingenious idea that years of 365 and 365¼ days were installed at the same time so that by the difference in days between the two New Years the number of years since the inauguration of the era could be determined. The idea of a year of 365¼ days in early use in Egypt, the so-called "fixed" year, dies hard. Unless the Ebers calendar be considered as such, and there are excellent reasons for not thinking so, there is "not one document giving equivalent dates in the known 'wandering' year and the hypothetical 'fixed' year. Furthermore, by the time that relations with the outside world were such as to result in unprejudiced foreign evidence on the customs of Egypt, we find the Egyptian both ignorant of, and unreceptive to, the idea."[2]

The second chapter, by Margaret S. Drower, gives the political background. Naturally, an attempt to sum up the history of the whole ancient Near East from the earliest times to the Persian empire in thirty-five pages is bound to be somewhat lacking in detail. Only the general picture can be drawn, and this the author has done quite well. A few corrections may be noted. Writing (p. 22) was probably an invention of Mesopotamia borrowed by Egypt rather than a separate discovery in both countries. The old view of the antagonism and racial conflict between the Semites and the Sumerians, still maintained by the author (p.

[1] W. F. Edgerton, "Chronology of the Twelfth Dynasty," *JNES*, I (1942), 308 ff.

[2] So H. E. Winlock, "The Origin of the Ancient Egyptian Calendar," *Proceedings of the American Philosophical Society*, LXXXIII (1940), 451.

25), needs revision in view of Jacobsen's discussion of the subject.[3] The so-called Code of Hammurabi (p. 30) was not a "legal code" but rather a "case book." The Assyrians did not win a victory at Karkar (p. 47) but at best drew the battle. They may even have suffered a defeat.

Six chapters follow which are devoted to the culture of pharaonic Egypt, writing and literature (Alan H. Gardiner), art (Jean Capart), materials and mechanical and technical processes (R. Engelbach), science (R. W. Sloley), medicine (Warren R. Dawson), and law (Erwin Seidl). The names of these contributors are sufficient assurance that these chapters are solidly informative and ably presented. A number of plates and illustrations add measurably to the value of the presentations of art, processes, and science.

Gardiner's chapter is especially interesting in that part which he devotes to a critical review and a reaffirmation of his theory that the origin of our alphabet is to be found in the Sinaitic inscriptions.

Two corrections to the chapter on science require mention. The *hekat* (p. 168) was not approximately a bushel. Since its content was 292 cubic inches (= 4.785 liters), it would take about 7½ *hekat*'s to make a bushel. The explanation of the *remen* (p. 176) needs clarification. According to the author, "the most important lineal unit was the royal cubit of 20.62 inches, divided into 7 palms or 28 digits. This was the side of a square of which the diagonal was 29.161 inches, the basis of land measure—the principal unit being the *remen*, half this diagonal." The basis of land measure was, of course, the cubit, both lineal and square. The error arises from the fact that there were three units of measure called *remen*, all deriving from its meaning of "half." The diagonal of a square cubit was considered by the Egyptians to be exactly 40 digits. A *remen* was half of this, or 20 digits; and this name has been found at the 20-digit mark on the ancient cubit measuring sticks preserved. The principal multiple of the lineal cubit was the *khet* or "rod" of 100 cubits. Half a *khet* was called a *remen*. The principal area unit was the square *khet* or "aroura." Half a square *khet* was also called a *remen*.

In his chapter on law Seidl discusses a court decision on the genuineness of a document (p. 201). According to him, the court decided that the defendant had only to bring three witnesses who would swear to its genuineness, not because they had been present when the document was drawn up, but because they had faith in the veracity of the defendant. Papyrus Berlin 9010, which Seidl is evidently discussing here, does not bear out his statement that the witnesses were strictly "character" ones. The decision states:

> If this Sebekhotep bring three reliable witnesses who can be trusted, who will make (oath): "Thy might be against him, O God! inasmuch as this writing was indeed made in accordance with the speech of this Woser [about it]," (the property) shall continue to be in the house of this Sebekhotep, after he has brought these witnesses in whose presence this speech was said. . . . . But if he does not bring three witnesses in whose presence [this] speech was said, then nothing of this Woser's shall remain with him. . . . .

The point is that the witnesses had to have heard Woser declare his intention, which was then embodied in a written document.

One chapter is devoted to the relations between Egypt and Israel (W. O. E. Oesterley). It might be pointed out that the earliest contact between Egypt and Syria-Palestine (p. 218) of which we have written evidence is from the reign of Snefru. The exile Sinuhe (p. 219) probably lived in southern Syria rather than southern Palestine; and on the whole question of the relations of Middle Kingdom Egypt with Palestine one should now see Wilson's study.[4] The dates and general course of events of the downfall of the Assyrian Empire (p. 231) has been the subject of a recent investigation.[5]

The last chapters in the book relate the history of Egypt after her own glory had largely passed, when she was under the domination of the Greeks, the Romans, and, lastly, the

[3] Thorkild Jacobsen, "The Assumed Conflict between Sumerians and Semites in Early Mesopotamian History," *JAOS*, LIX (1939), 485 ff.

[4] John A. Wilson, "The Egyptian Middle Kingdom at Megiddo," *AJSL*, LVIII (1941), 225 ff.

[5] Waldo H. Dubberstein, "Assyrian-Babylonian Chronology (669–612 B.C.)," *JNES*, III (1944), 38 ff.

Arabs. The contributions which the Greek papyri have made to our understanding of this late period are ably dealt with by C. H. Roberts, and A. H. M. Jones discusses with discernment the interchanges between Egypt, Greece, and Rome. The large topic of Egypt and Christianity is divided between J. M. Creed and De Lacy O'Leary, with the former outlining the effect of Egypt upon the development of the Christian church with special reference to Origen, and the latter relating the debt which monasticism owes Egypt.

"Egypt and the Byzantine Empire" is discussed by H. I. Bell. The period from Diocletian to the coming of the Arabs, some four centuries, was one of great change for all the Roman world, and Egypt suffered with the rest. The decay which weakened the country economically and spiritually made her an easy prey to the newcomers on the historical scene. But, as usual, Egypt altered her conquerors more than they altered her, though this aspect of Egypt and Islam is rather ignored by A. J. Arberry, who emphasizes, instead, the contributions made by Egyptian-born Arabs to literature, architecture, and the other arts.

A final chapter, by A. M. Hocart, sums up in extremely interesting fashion the legacy to modern Egypt. He shows how the oldest conceptions of the state and kingship, of religion and the gods, of ordinary life and social organization, have not been lost through the centuries but have been adapted and are effective even today. Much might yet be possible for modern Egypt, if it could but awaken to the glory of its heritage, not in blind, introspective admiration, but with a sense of challenge and of continuity.

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Coptic Egypt. Edited by JOHN D. COONEY. Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences, Brooklyn Museum, 1944. Pp. 58. $0.75.

The Brooklyn Museum is to be most cordially congratulated on the very respectable series of publications which it has been issuing in late years. Cooney's *Late Egyptian and Coptic Art* (*JNES*, III [1944], 108) is here supplemented by a publication of the papers read at a 1941 symposium held under the joint auspices of New York University and the Museum in connection with an exhibition entitled "Paganism and Christianity in Egypt." Westermann's survey of Coptic backgrounds and Nock's paper on the Copt religion are models of incisive presentation. Nersessian emphasizes the importance of Coptic painting as a reflection of the religious beliefs of the Copts, and Dimand endeavors to solve some of the problems connected with the dating and classification of Coptic textiles. A modified form of Cooney's introduction to the catalogue of the Brooklyn exhibition is reprinted, and Dows Dunham gives a foretaste of what may be expected from final publication of the highly significant excavations of Harvard and Boston in Coptic sites. Each paper is provided with a well-chosen bibliography, and the inexpensive volume thus becomes a key to a general knowledge of the civilization of Egypt during the early Christian period.

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Hittite Hieroglyphs, III. by IGNACE J. GELB. ("Oriental Institute Studies in Ancient Oriental Civilization," No. 21.) University of Chicago Press, 1942. Pp. xix+75. $1.75.

Professor Gelb has now, after the publication of the three parts of his *Hittite Hieroglyphs* (1931, 1935, 1942; cf. my review, *AJSL*, XLIX, 61–66, and notices, *BASOR*, No. 61, p. 30, and No. 88, p. 40) and his *Hittite Hieroglyphic Monuments* ("Oriental Institute Publications," Vol. XLV [Chicago, 1939]) taken the lead in the effective decipherment of Hittite. His first monograph was of great significance in laying a solid foundation for the decipherment of the Hittite syllabic characters, thanks to his recognition that these characters must in principle represent consonant+vowel, for which he cited the number of phonetic characters which corresponded closely to the number of Cypriote characters, especially since it could be shown that the two systems agreed in employing only one sign for each stop sound. At that time I accepted Gelb's principal con-

tentions but criticized his linguistic method. Since then his basic discovery about the nature of the syllabary has been accepted by Hrozný, Meriggi, and others, and his linguistic method has improved greatly.

In the study before us Gelb devotes himself to a renewed examination of the Hittite hieroglyphic syllabary, with a number of improvements which consolidate our knowledge in a satisfactory way. I think that he is inclined to overdo the principle that each character must represent consonant + vowel, and I agree with certain objections of Meriggi. In particular, the so-called "tang" should probably be *+r* not *ra*, *r(a)*, as Gelb now thinks. In practically all proper names whose reading can be confirmed from cuneiform sources the tang seems to close a syllable: e.g., *Wa+r-pa-la-wa-* = Assyr. *Ur-pal-la-a* (Bossert); *U+r-ḫi-li-na-* = Assyr. *Ur-ḫi-li-ni*. Gelb's extremely plausible theory that two of the signs on page 2 are nasalized *ã* and *ĩ* belongs in the same picture, since it is probable that Hittite final *r* was very weak (cf. *Hittite Hieroglyphs I*, p. 13, n. 1). The striking parallelism between the Egyptian syllabic orthography (on which see my *Vocalization of the Egyptian Syllabic Orthography* [New Haven, 1934]) and the Hittite hieroglyphic system (which Gelb first called to my attention) thus extends to the principal consonant+vowel and also to the inclusion of characters representing vowel+*r* and *n* (though the quality of these sounds in Egyptian was quite different from their probable quality in Hittite). It may be added that there are also several instances of more complex phonetic rebus in Hittite (Gelb, pp. 37–38), just as in Egyptian (*Vocalization*, p. 27, to which I can now add a few additional cases). It is premature, of course, to infer that the Hittite syllabary was developed under Egyptian influence (though this has been plausibly inferred for the Hittite hieroglyphic system as a whole and there is no chronological difficulty involved).

I am increasingly convinced that the reading *ḫa*, *ḫe*, *ḫi*, *ḫu* of the four characters discussed in *Hittite Hieroglyphs, II* (pp. 16–19) and *Hittite Hieroglyphs, III* (p. 5), should be corrected to *ḡe*, *ḡa*, *ḡi*, *ḡu*, respectively. This correction is phonetic, not systematic, and no equations of Gelb's are affected by it. In the first place, Egyptian transcriptions show that the Egyptians heard the Hittite "*ḫ*" as a variant of *g*, without any relation to the Egyptian front velar *ḫ* or back velar *ḥ* (on these sounds see Worrell, *Coptic Sounds*, pp. 37 ff.). Thus Hittite *Giluḫepa* appears in Egyptian syllabic transcription as *Ki-r-gi-p(a)*; the Hittite divine name *Tarḫu*^{bu} (Gelb, p. 4, etc.) appears as *Ta-r-ga-* (*Vocalization*, p. 63, XIX. A. 16, and for various forms of the divine name in question also Friedrich, *Kleinasiatische Forschungen*, I, 370). Moreover, the equivalence ^{d}*Pa-x-la-ta-* strongly suggests a consonantal value *ḡ-* rather than *ḫ-*, since *ḡ* is more like the putative ʿ in the Semitic original *Baʿlat(a)* than is *ḫ*. In the second place, the sign read "*ḫa*" by Gelb should be *ḡe* in the name ^{d}*Ḡe-pa-tu* = *Ḥepat* (Egyptian *Gi-pa*) and in a personal name containing the same element. Hrozný had already considered the values *ḫe* and *ḫi* as well as *ḫa* for it. Moreover, Hrozný had read Gelb's *ḫa* (my *ḡe*) as *ḫe*, my *ḡa* as *ḫá*.

Gelb's latest effort to solve the long-standing enigma of the bilingual seal of "Tarkondemos" returns to his older reading of the cuneiform legend as ^{m}*Tar-qu-u-tim-me* and proposes that the Hittite inscription be read as *Tarḫu-zi* (pp. 26–29). The basis for reading the second sign as *zi* is weak, depending as it does on a single broken character in another inscription, and the distance between the cuneiform and hieroglyphic forms is extraordinarily great. It is at least as possible that the reading ^{m}*Tar-qu(m)-mu-wa*, which I proposed in 1927 and Friedrich defended very vigorously in 1930, is correct, and that the hieroglyphic character is an ideogram for *muwa* (a word which Gelb finds elsewhere in the Hittite vocabulary in the meaning "strong, great"; cf. p. 9 of the present study). However, only the future can establish the correct reading of this remarkable seal, now in the Walters Gallery in Baltimore (Dorothy K. Hill, *Archiv orientální*, 1937, pp. 307 ff.).

In conclusion we wish to congratulate the author on another valuable contribution to the decipherment of the Hittite hieroglyphs.

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The Three Ages: An Essay on Archaeological Method. By GLYN E. DANIEL. Cambridge: University Press; New York: Macmillan Co., 1943. Pp. 60. $0.75.

This is an exasperating little book. In all fairness to the author, it may be said that this reviewer's exasperation stems mainly from the confusion of terminology current in Old World prehistory. The author is not overly brave in his struggles with this situation; many things said here have been said as well before, and no Gordian knots are cut. On the other hand, the author succeeds in worrying many of the problems of the various schemes of terminology out into the open, and the book could be the starting-point for the construction of an objective taxonomic system.

The claimed object of the book is "briefly to describe the origins and development of the idea of the three ages" which C. J. Thomsen set forth in 1836, the "division of human history, on the basis of the raw materials of industry, into three ages—the Stone Age, the Bronze Age, and the Iron Age." The author continues that he means to discuss the idea of the three ages as to "some of the aspects of its applicability to the modern study of prehistoric archaeology." His conclusion seems to be that "the Thomsen three-age system remains a generalization about the technical development of man .... a generalization which, at the present day, assumes little importance when compared with other generalizations such as those of the functional-economic scheme." With reference to the subtitle, the book contains nothing of archeological method in the sense of excavation or preparation techniques; the method concerns itself rather with terminology and classification.

The first section of the book is a historical account of Thomsen, the background and surroundings in which his system arose, and its subsequent stratigraphic demonstration in Denmark. The second section discusses the implications of the three-age system, the classic exceptions to it (e.g., Africa), and the elaborate subdivisions which have been imposed on the system in northwestern Europe. The third section examines the different usages which the author feels have rightly or wrongly been imposed on the system and its subdivisions: (1) the typological usage, (2) the cultural usage, (3) the chronological usage, (4) the functional-economic usage, and (5) other usages such as the diffusionist one and the question of whether the three-age system actually has primary significance at all in human prehistory. The fourth section of the book is a summary.

It is the third section—that on usages—which is most uncomfortable. Using the three-age system as a vehicle, the author makes it quite apparent that he is unhappy about the confusion of terms which exists in Old World prehistory, but he does little to remedy the situation. One example of the author's train of thought must suffice here. He retains the term "culture" for prehistoric archeology; he objects that "it is as mistaken for anthropologists to declare that all prehistoric cultures are merely assemblages of artifacts as for archaeologists to pretend that they can treat all prehistoric cultures as anthropologists do living ones." On the other hand, he admits that "prehistoric cultures appear to us as little more than significant and persistent associated assemblages of artifacts," whereupon it is necessary for him to qualify "appear" with "notwithstanding appearances, a prehistoric culture *was* very much more than its archaeological expression at the present day" (the emphasis is ours). Other definitions follow; for example: "An industry is a facies of a culture and a culture is an agglomeration of industries." One is bound to wonder what kind of an agglomeration of industries is the "Chellean culture," which seems at best to consist of a single flint type tool and various "atypical" flint flakes, in geological context only.

It is high time for a housecleaning in the terminology of Old World prehistory and for the construction of an objective taxonomic scheme with respect to the available artifactual evidence alone (with its stratigraphic and regional contexts). The word "culture" has meaning in the social sciences,[1] and its use in prehistoric archeology, even if approached

[1] Cf. David Bidney, "On the Concept of Culture and Some Cultural Fallacies," *American Anthropologist*, XLVI (new ser., 1944), 30 ff.

from the humanistic point of view, can lead to nothing but confusion. "Culture" should not appear in the taxonomic scheme. The word "assemblage" would seem to be a useful one, especially if it were to describe the available total of artifacts, nonartifactual materials (associated fauna, flora, minerals, etc.) and such nonmaterial traits as do appear in prehistoric ranges (e.g., burial customs), which are persistently associated in a given archeological horizon and area. "Industry" or some term roughly synonymous with it would be useful in describing the various available tools in single catagories of material, e.g., the Acheulean flint industry, the Magdalenian bone industry. This would tend to remind us of the true paucity of our knowledge of the earlier ranges of prehistory in particular (where no "assemblages" would yet be available). It would also save us some embarrassment in case we presently find, for example, that more than one now recognized flint "industry" may have archeological context (in the "assemblage" sense) with another.[2] Taxonomic terms of a degree higher than "assemblage" could be decided upon without choosing words having the implications of "culture" or "civilization."[3] These last should be retained for those ranges of historic archeology where art and writing so complement the normal objects of an assemblage that an understanding of the life and thought of the people in question may be implied.

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The Problem of Ezekiel: An Inductive Study. By WILLIAM A. IRWIN. Chicago: University of Chicago Press, 1943. Pp. xx+344. $3.00.

No brief review can suggest adequately the significance of this book. Also, it is easier to criticize an interpretation of the difficult Book of Ezekiel than to offer a countersolution subject to less objection. The reviewer's job is far easier than that to which Professor Irwin has set himself. The author has given us a thoroughly original, clear-cut, rigorously applied approach to the problem of Ezekiel. The problem is the recovery of the original core of the Book of Ezekiel. Ezekiel's oracles, save for the introductory material, were exclusively poetical and are to be found in fifty-five passages, some of which are composite. Twenty-one of the prophet's utterances consisted of a single line; twenty-three are a single distich couplet. The author adds that at some points he may have been too generous with Ezekiel and so may have accepted phrases which are late and

[2] Cf. H. de Terra and H. Movius, Jr., "Research on Early Man in Burma," *Transactions of the American Philosophical Society*, XXXII, Part III (1943), 377. Here Movius, speaking of the biface and flake tool preparation traditions of the Lower Paleolithic of Europe, writes that "except on the extreme northwestern periphery of their distribution—i.e., France and England—these two types of implements, sometimes considered to be mutually distinct industries, cannot be segregated as separate and independent developments." This is a point which needs to be made loudly and often by Old World prehistorians, and, in conjunction with it, the present lack of proper archeological (as against geological) association of artifacts in the Lower Paleolithic of Western Europe should be borne in mind.

[3] There are two taxonomic systems in current use in North American archeology, which is, of course (in pre-contact times), fully prehistoric. One of these was devised for the southwestern United States by W. and H. S. Gladwin, *A Method for the Designation of Cultures and Their Variations* ("Medallion Papers," No. 15 [Gila Pueblo, Globe, Arizona, 1934]). The terminology proceeds from "roots" (mainly postulated) through "stems," "branches," and "phases." The system has been corrected and refined since its publication, but there is no recently published appraisal of its usage.

The more widely used scheme is the so-called "McKern taxonomic system," which has recently been appraised in detail by J. B. Griffin in *The Fort Ancient Aspect* (Ann Arbor; University of Michigan Press, 1943), esp. pp. 327–41. The terminology proceeds from "patterns" through "phases," "aspects," and "foci" to "components"; the classification of materials into the various degrees of relationship implied is based on the number of traits which the assemblages in question have in common. Regardless of the subjectivity which may enter into such matters as the "weighting of traits," the McKern system has brought order out of chaos in the eastern and central portions of Canada and the United States.

It does not follow that either of these systems could be directly applied in the Old World but only that the experience gained in their formulation and application might be of value in the construction of an Old World taxonomic scheme. The author of *The Three Ages* is conscious of T. T. Paterson's provocative ventures at the classification of Old World Pleistocene geology, Lower Paleolithic archeology, and human paleontology (*Nature*, CXLVI [1940], 12 ff.), but does not attempt to meet the problems rising out of the Paterson scheme.

trite intrusions. More than 80 per cent of the book is secondary. Much is false commentary on Ezekiel's oracles or commentary on commentary.

Professor Irwin's key to the Book of Ezekiel is his inductive approach. Analyzing chapter 15, he discovers a small, original, poetic core in verses 2–5, with the introductory formula, "And the word of the Lord came to me saying, 'Son of man.' " The rest of the chapter is false commentary. Having thus determined the literary structure of this chapter with what he regards as considerable certainty, Professor Irwin then applies this knowldge in the interpretation of other chapters. Turning to chapters 4 and 5, he finds an original poem of three strophes in 4:1, 2, 9–11 and 5:1–3, while the rest is not merely one commentary but comment on comment. Considerable revision or rearrangement of the text is sometimes necessary to recover the original poetic oracle, which may be at times separated from the introductory formula. Chapters 9, 10, 19, and 39–48 are completely spurious. The expression, "Therefore, thus says the Lord," commonly introduces false commentary, being never used by Ezekiel. The commentators range in date from the Exile to somewhere about the beginning of the present era. "Hosts of men in far lands and diverse ages have enriched it [the Book of Ezekiel] with their devout musings and thought." The commentators wrote in Palestine, in Babylonia, in Egypt, possibly in Syria, and perhaps in the hills of Media and among the sons of Javan. Their work ranges from a simple gloss to lengthy paragraphs. None wrote a full chapter, for the commentaries are composite. The literary history of the Book of Ezekiel is unique.

Ezekiel began to prophesy, according to Professor Irwin's findings, about 600 B.C. He was not among the exiles of 597, but after the fall of Jerusalem in 586 he went into Babylonia. His Palestinian oracles were consistent criticism and warnings. In 12:21 ff., where an original poem is discovered, there is an oracle of comfort which "there seems every reason to date after 586 B.C." In this later period he promised the restoration of Israel and Judah. The doctrine of individualism is his only in embryo, since in chapter 18 the original poem is confined to a single tristich line in verse 4. Among other things, the evidence that Ezekiel was a North Israelite, a priest, or a mystic with abnormal psychic experiences disappears.

The study begins with an excellent summary of the history of the interpretation of the problem of Ezekiel, from Oeder and Vogel in 1771 to Cooke, Bertholet, and Matthews. Professor Irwin always writes with a consciousness of the history of interpretation. There are six concluding chapters, dealing with the dates (all are spurious, save perhaps 1:1, which may refer to the thirtieth year of Ezekiel's life), the criteria, the results, the history of the Book of Ezekiel, the work of Ezekiel, and Ezekiel's career and book. The body of the study, under the heading "Induction," is a chapter-by-chapter application of the author's methodology.

Despite its inductive character, one may wonder whether another scholar, using Professor Irwin's methodology, and working independently, would closely approximate his conclusions, picking out, for instance, the same poem in chapters 14, 27, 30, etc. Frequent statements that certain reconstructions are obvious, without question, or beyond doubt are clearly intended to be qualified in the mind of the reader by the frank recognition in the Introduction that the inductive method applied in literary criticism lacks the objectivity possible in the natural sciences. As the reviewer read and reread the book, the following question constantly disturbed him. If the history of the Book of Ezekiel is that presumed by Professor Irwin, could we ever hope to recover Ezekiel's oracles? Would we not be in a position worse than that of the adherents of the more radical forms of the New Testament *Formgeschichte* school?

Some will question whether the author does not demand of Ezekiel too great logical consistency, particularly in the interpretation of the details of Ezekiel's symbolism. From the prophet's viewpoint, does the contrast between the symbolism of the mongrel ancestry of Jerusalem in 16:3 and the abandoned baby in 16:4 ff. demand such serious consideration? It may seem "absurd" to us that in chapter 17

a vine directs its roots toward an eagle in flight and a cedar tree bears fruit, but was not the symbolism but a means to an end to Ezekiel? Equally strange figures occur in oriental art. That in chapter 19 even the last of the kings of the Hebrews are symbolized as rampant lions is not, after all, so strange. Although to Professor Irwin's mind the use of the cedar of Lebanon as a symbol of the land of the Nile is as improbable as any figure can well be, Ezekiel may not have found it so, and the cedars of Lebanon, in any case, were not unimportant to the Egyptians. When Ezekiel uses, of the city of Tyre, the siege symbolism which is more applicable to a city not on an island, may we not take it as an example of the way in which Ezekiel used symbolism and so obviate the necessity of bringing the text down to the time of Alexander or of divorcing it from any allusion to Tyre? Is it our more rigorous occidental logic which causes us to think that the throne chariot has intruded uninvited into the picture? How can we know that a verse is a crude copy of the style and content of the preceding verses, and so a commentary on it, rather than just an illustration of the author's style? When is a phrase a redundant gloss? The reviewer agrees that verses 3–31 of chapter 34 are not original with Ezekiel, but the necessity of separating them from the first two verses is not apparent to him. He believes, with the author, that the doctrine of individualism in 18:5–32 is not Ezekiel's, but it is not apparent to him that they should be separated from verses 1–4. So also in chapters 38 and 39, where Professor Irwin isolates as the original oracle but a single tristich line, in 38:3*b*, 4, and says that "here is genuine material beyond any possibility of doubt." The reviewer finds much more unity in the non-Ezekielian materials and cannot delimit so narrowly or limit to poetry the oracles of Ezekiel. Among other things, he considers the throne-chariot visions in the first chapters to be original and thinks that it follows that the larger part of chapters 40–48 belong to Ezekiel. The fact of disagreement does not make Professor Irwin wrong! We may note in passing that in 33:21 the reading 11/10/5 (= Jan. 586) in the LXX, Syriac, and some Hebrew manuscripts cannot be correct, since this would place the event before the fall of Jerusalem in 11/4/9 (= July 586).[1]

The relation of the LXX to the Hebrew text naturally occupies much of the author's attention. He rightly makes considerable use of the important Greek payprus No. 967. Perhaps he gives too much credence to the LXX. The reviewer has attempted to show at another place (*JBL*, LXI, 152 ff.) that the vocabulary of many of the passages in Jeremiah omitted by the LXX is pre-LXX in date and that we must consider them *omissions* in the LXX rather than post-LXX additions to the Hebrew text. Even the famous passage in Jer. 33:14–26 is probably pre-LXX, and that it refers to the Davidic and Hasmonean families, and is to be placed after A.D. 70, seems completely incredible. If the Hebrew text used by the LXX translator did not contain this passage, then we must assume that his Hebrew text had omitted it, not that the passage originated later than the time of the translation. The LXX translators also at times deliberately made a more concise translation, omitting redundant expressions. This is particularly true in the case of Jeremiah, and a good example in Ezekiel is found in 6:5*a*, which the LXX and Professor Irwin omit as but a trite repetition of 6:4*b*. A study of 36:23 ff. convinces the reviewer that it is pre-LXX in date, although omitted by Codex 967. In thought and style it belongs with the other "new heart" passages in Jeremiah and Ezekiel. It is most probably a LXX *omission*, whether we can explain the reason for its omission, as Professor Filson thinks, or cannot, as Professor Irwin thinks. If this passage, which has so much in common with passages which are in the LXX, is not to be explained as an actual omission in Codex 967, it may be only that the particular Hebrew manuscript from which it was translated did not contain it, not that it is post-LXX in date. In any case, if the history of the Hebrew text of the Book of Ezekiel is something like what Professor Irwin thinks it to have been, it would follow, as he recognizes, that there would have been many variant Hebrew texts in circulation in antiquity.

A book which will be read and discussed as

[1] Cf. Morgenstern, *JNES*, II (1943), 127.

widely as this one deserves a better format than its present paper cover and reproduction of the typed page. There is no doubt but that it will elicit important and constructive discussion which will add much to our understanding of the Book of Ezekiel. The reviewer is a former student of the author and felt himself again sitting at his feet. Professor Irwin has recovered most of the main themes of Ezekiel's oracles. Even those who cannot accept the author's thesis in most of its detail will find the book rich with suggestions for textual exegesis. The author would probably agree that complete acceptance of his interpretation would indicate an uncritical attitude. He is to be commended for the manner in which he describes his technique in sharp detail and rigorously applies it. We may close this review by noting a few of the many excellent statements in the book concerning proper principles of exegesis. Commonly when we give more attention to the text, we feel less need of tampering with it. The Hebrew text is of prime importance, far surpassing that of the LXX, for the criticism of the Book of Ezekiel. Exegesis must follow, not determine, textual conditions. There is a too common practice of *making* Hebrew poetry rather than finding it. We must always give the benefit of any doubt to the conservative position. No formulation of guides and criteria can ever provide ultimate rules for the dissection of a literary work. To all this we say, "Amen!" We stand much indebted to Professor Irwin for this important book on the Book of Ezekiel.

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Das Haus Egibi in neubabylonischen Rechtsurkunden. By SAUL WEINGORT. Berlin: Buchdruckerei Viktoria, n.d. Pp. 64.

This doctoral dissertation by Dr. Weingort, student of Professors Ebeling and Koschaker, investigates the history of one of the important business families in the late Babylonian period. A large part of the study concerns itself with tracing the Egibi family tree, and several diagrams are useful in guiding the reader through complex relationships. An appendix discusses linguistic problems which appear in pertinent texts. An admirably classified index gives full references. A brief interpretation of the economic and social materials found in the texts concludes the dissertation.

The chief criticism or regret one might express in surveying this study is that not more space was devoted to interpreting the hundreds of texts dealing with the varied and highly interesting activities of the Egibi house. The problems treated in the Appendix seem to have been chosen on an arbitrary basis. For example, (*amēl*) *urâšu*, *duppi-duppi*, *aḫi*, *mala*, some of the phrases investigated by the author, seem to offer little difficulty, while other unsolved problems, such as the precise meaning of the several attributes of silver, are not included. However, the concise delineation of Egibi relationships and the scholarly presentation of the evidence make this study a contribution to late Babylonian history.

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The Ansāb al-ashrāf of al-Balādhurī, Vol. IVB: *Indices*. Edited by MAX SCHLOESSINGER. Jerusalem: Hebrew University Press, 1940. Pp. 36.

The decision to issue indexes to this valuable publication in single volumes and even partial volumes as they appear is both generous and wise. Though it will entail much duplication in the end, for present use this decision will render many students happily grateful. Beside the prefatory statement in both English and Hebrew the slim fascicle contains two and a half pages of additions and corrections in addition to the indexes.

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